Exhibit 4

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

In re *Inter Partes* Review of:

U.S. Patent No. 9,256,311

For: Flexible Touch Sensor

DECLARATION OF ANDREW WOLFE, PH.D.

Mail Stop PATENT BOARD
Patent Trial and Appeal Board
US Patent and Trademark Office
PO Box 1450
Alexandria, Virginia 22313-1450

I, Andrew Wolfe, Ph.D., declare as follows:

1. I have been retained as a technical consultant on behalf of Samsung Display Co., Ltd., who I understand is the petitioner in the present proceeding, as well as on behalf of Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc., who I understand are identified as "real parties in interest" in the present proceeding. I will refer to these entities collectively in this declaration as "Petitioners" or "Samsung." I have been asked to consider whether the references listed as Exhibits 1003-1008 below disclose or suggest, alone or in combination, the limitations recited in the claims of U.S. Patent 9,256,311 (the "'311 patent"). I have also been asked to consider the state of the art and the prior art available before the time the '311 patent was filed. My opinions are provided in this declaration.

2. To the best of my knowledge, I have no financial interest in Petitioners, Petitioners' counsel has informed me that a company known as Solas OLED Ltd. purports to own the '311 patent. To the best of my knowledge, I have no financial interest in Solas OLED Ltd. and, to the best of my recollection, I have had no contact with Solas OLED Ltd. or the named inventors of the patent, Esat Yilmaz, Steven Alan Laub, or Jalil Shaikh. To the best of my knowledge, I similarly have no financial interest in the '311 patent. To the extent any mutual funds or other investments that I own have a financial interest in the Petitioners, the Patent Owner

or the ’311 patent, I am not aware of, nor do I have control over, any financial interest that would affect or bias my judgment.

3. I am being compensated at my standard consulting rate for my time. My compensation is in no way contingent on the results of these or any other proceedings relating to the above-captioned patent.

1. BACKGROUND AND QUALIFICATIONS

4. My name is Andrew Wolfe. My complete qualifications and professional experience are described in my curriculum vitae, a copy of which is provided as Exhibit 1024. The following is a brief summary of my relevant qualifications and professional experience.

5. I am the founder and sole employee of Wolfe Consulting. Through Wolfe Consulting, I provide technical and business analysis to businesses on processor technology, computer systems, display technology, consumer electronics, software, design tools, data security, cryptography, and intellectual property issues. I have more than thirty years’ experience developing products, researching, consulting, and teaching in those fields. In that time, I have worked as a computer architect, computer system designer, and as an executive in the PC and electronics business. I have also taught at some of the world’s leading institutions in those fields, including Stanford University, Princeton University, Carnegie Mellon University, and Santa Clara University.

6. In 1985, I earned a B.S.E.E. degree in Electrical Engineering and Computer Science from the Johns Hopkins University. In 1987, I received a M.S. degree in Electrical and Computer Engineering from Carnegie Mellon University. In 1992, I received a Ph.D. degree in Computer Engineering from Carnegie Mellon University. My doctoral dissertation proposed a new approach for the architecture of a computer processor. My undergraduate Senior Project involved characterizing and filtering noise and interference in capacitive touchscreens.

7. In 1983, I began designing touch sensors, microprocessor-based computer systems, and I/O (input/output) cards for personal computers as a senior design engineer for Touch Technology, Inc. During the course of my design projects with Touch Technology, I designed I/O cards for PC-compatible computer systems, including the IBM PC-AT, to interface with interactive touch-based computer terminals that I designed for use in public information systems. I continued designing and developing related technology as a consultant to the Carroll Touch division of AMP, Inc., where in 1986 I designed one of the first custom touch-screen integrated circuits. I designed the touch/pen input system for the Linus WriteTop, which many believe to be the first commercial tablet computer.

8. From 1986 through 1987, I designed and built a high-performance computer system at Carnegie Mellon University. From 1986 through 1988, I also

developed the curriculum and supervised the teaching lab for the processor design courses.

9. In 1989, I worked as a senior design engineer for ESL-TRW Advanced Technology Division. I designed and built a bus interface and memory controller for a workstation-based computer system and worked on the design of a multiprocessor system.

10. At the end of 1989, along with some partners, I reacquired the technology I had developed at Touch Technology and at AMP and founded The Graphics Technology Company. As an officer and a consultant, I managed engineering development activities at that company and personally developed dozens of interactive graphics and interactive video computer systems over the next seven years.

11. I have consulted, formally and informally, for a number of processor design companies. In particular, I have served on the technical advisory boards for two media processor design companies, BOPS, Inc., where I chaired the board, and Siroyan Ltd. I served in a similar role for three networking chip companies, Intellon, Inc., Comsilica, Inc., and Entridia, Inc. and one 3D game accelerator company, Ageia, Inc. I have also served as a technology advisor to Motorola and to several venture capital funds in the U.S. and Europe. Currently, I am a director of Turtle Beach Corporation, providing guidance in its development of premium audio

peripheral devices and user-input devices for a variety of commercial electronic products.

12. From 1991 through 1997, I served on the Faculty of Princeton University as an Assistant Professor of Electrical Engineering. At Princeton, I taught undergraduate and graduate-level courses in Computer Architecture, Advanced Computer Architecture, Display Technology, and Microprocessor Systems courses as well as conducting sponsored research in the area of computer systems and related topics. I also was a principal investigator for DOD research in video technology and a principal investigator for the New Jersey Center for Multimedia Research. From 1999 through 2002, I also taught the Computer Architecture course to both undergraduates and graduate students at Stanford University several times as a Consulting Professor. At Princeton, I received several teaching awards, both from students and from the School of Engineering. I have also taught advanced microprocessor architecture to industry professionals in IEEE and ACM sponsored seminars. I am currently a lecturer at Santa Clara University teaching courses on Microprocessor Systems, Real-time Embedded Systems, and Mechatronics.

13. From 1997 through 2002, I held a variety of executive positions at a publicly-held PC graphics company originally called S3, Inc. and later called Sonicblue Inc. These included Chief Technology Officer, Vice President of Systems Integration Products, Senior Vice President of Business Development, and Director

of Technology. At the time I joined S3, it supplied graphics accelerators for more than 50% of the PCs sold in the United States. As CTO, I led the development and introduction of more than 30 new consumer electronics products. I was also part of a team that developed the Frontpath Progear tablet computer in 2000.

14. I have published more than 50 peer-reviewed papers in computer architecture and computer systems design. I have also chaired IEEE and ACM conferences in microarchitecture and integrated circuit design. I am a named inventor on at least fifty-six U.S. patents and thirty-seven foreign patents. A list of my publications is included in Exhibit 1024.

15. I have been the invited keynote speaker at the ACM/IEEE International Symposium on Microarchitecture and at the International Conference on Multimedia. I have also been an invited speaker on various aspects of technology or the PC industry at numerous industry events including the Intel Developer's Forum, Microsoft Windows Hardware Engineering Conference, Microprocessor Forum, Embedded Systems Conference, Comdex, and Consumer Electronics Show as well as at the Harvard Business School and the University of Illinois Law School. I have been interviewed on subjects related to computer graphics and video technology and the electronics industry by publications such as the Wall Street Journal, New York Times, LA Times, Time, Newsweek, Forbes, and Fortune as well as CNN, NPR, and the BBC. I have also spoken at dozens of universities including

MIT, Stanford, University of Texas, Carnegie Mellon, UCLA, University of Michigan, Rice, and Duke.

16. Additional details of my education and work experience, awards and honors, and publications that may be relevant to the opinions I have formed are set forth in my CV (Exhibit 1024).

17. In summary, I have extensive familiarity with fields involving electronic device user interfaces, touchscreens, and displays. I am familiar with what the state of this field was at the relevant time up to the time that the ’311 patent was filed.

2. MATERIALS REVIEWED

18. I am not an attorney and offer no legal opinions, but in my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

19. In preparing this declaration, I reviewed the ’311 patent, including the claims of the patent in view of the specification, and its family members, and I have reviewed the prosecution history of the ’311 patent and numerous prior art and technical references from the time of the alleged invention. More specifically, I have reviewed each of the following:

Exhibit	Description
1001	U.S. Patent No. 9,256,311 (“the ’311 patent”)

Exhibit	Description
1002	File History for U.S. Patent No. 9,256,311
1003	U.S. Patent No. 8,722,314 (“Kuriki”)
1004	U.S. Patent No. 9,395,851 (“Mikladal”)
1005	U.S. Patent Application Pub. No. 2011/0102361 (“Philipp”)
1006	U.S. Patent Application Pub. No. 2012/0218219 (“Rappoport”)
1007	International Publication No. WO 2010/099132 (“Moran”)
1008	U.S. Patent Application Pub. No. 2008/0223708 (“Joo”)
1009	International Publication No. WO 2011/107666
1010	U.S. Patent Application Pub. No. 2010/0045632 (“Yilmaz”)
1011	Atmel Touch Sensors Design Guide, Rev. E (Sept. 2009)
1012	U.S. Patent Application Pub. No. 20100123670
1013	U.S. Patent Application Pub. No. 20090219257 (“Frey I”)
1014	U.S. Patent Application Pub. No. 20100156840 (“Frey II”)
1015	U.S. Patent No. 9,400,576 (“Chen”)
1016	International Publication No. WO 2011/107665 (“Brown”)
1017	International Publication No. WO 2011/062301
1018	*Scalable Coating and Properties of Transparent, Flexible, Silver Nanowire Electrodes*, Hu et al. (Apr. 28, 2010)
1019	U.S. Patent Application Publication No. 20110253668
1020	U.S. Patent Application Publication No. 20110007011
1021	U.S. Patent Application Publication No. 20120111479 (“Sung”)

Exhibit	Description
1022	*SmartSkin: An Infrastructure for Freehand Manipulation on Interactive Surfaces*, Rekimoto (Apr. 2002)

3. RELEVANT LEGAL STANDARDS

20. I am not an attorney. For the purposes of this declaration, I have been informed about certain aspects of the law that are relevant to forming my opinions. My understanding of the law is as follows:

21. Petitioners' counsel has informed me that a patent claim may be "anticipated" if each element of that claim is present either explicitly or inherently in a single prior art reference, and that the elements should be arranged in the reference as in the claim. Petitioners' counsel has informed me that for a claimed limitation to be inherently present, the prior art need not expressly disclose the limitation, so long as the claimed limitation necessarily flows from a disclosure in the prior art.

22. Petitioners' counsel has informed me that a patent claim can be considered to have been obvious to a person of ordinary skill in the art at the time the application was filed. This means that, even if all of the requirements of a claim are not found in a single prior art reference, the claim is not patentable if the differences between the subject matter in the prior art and the subject matter in the

claim would have been obvious to a person of ordinary skill in the art at the time the application was filed.

23. Petitioners' counsel has informed me that a determination of whether a claim would have been obvious should be based upon several factors, including, among others:

- the level of ordinary skill in the art at the time the application was filed;
- the scope and content of the prior art; and
- what differences, if any, existed between the claimed invention and the prior art.

24. Petitioners' counsel has informed me that a single reference can render a patent claim obvious if any differences between that reference and the claims would have been obvious to a person of ordinary skill in the art. Alternatively, the teachings of two or more references may be combined in the same way as disclosed in the claims, if such a combination would have been obvious to one having ordinary skill in the art. In determining whether a combination based on either a single reference or multiple references would have been obvious, it is appropriate to consider, among other factors:

- whether the teachings of the prior art references disclose known concepts combined in familiar ways, and when combined, would yield predictable results;

- whether a person of ordinary skill in the art could implement a predictable variation, and would see the benefit of doing so;

- whether the claimed elements represent one of a limited number of known design choices, and would have a reasonable expectation of success by those skilled in the art;

- whether a person of ordinary skill would have recognized a reason to combine known elements in the manner described in the claim;

- whether there is some teaching or suggestion in the prior art to make the modification or combination of elements claimed in the patent; and

- whether the innovation applies a known technique that had been used to improve a similar device or method in a similar way.

25. Petitioners' counsel has informed me that one of ordinary skill in the art has ordinary creativity and is not an automaton. Petitioners' counsel has informed me that in considering obviousness, it is important not to determine obviousness using the benefit of hindsight derived from the patent being considered.

26. Petitioners' counsel has informed me that under specific circumstances whereby a secondary reference is not being used to teach a limitation but rather to explain the teachings of a primary reference, a specific motivation to combine need not be identified; however, in the case of the combination of art discussed in this declaration, a specific motivation to combine is present and I have identified it.

27. Petitioners' counsel has also informed me that, in this proceeding, the claim terms should be given their plain and ordinary meaning as understood by one of ordinary skill in the art (a "POSITA"), consistent with the disclosure and the prosecution history.

4. TECHNOLOGY BACKGROUND

28. The filing date listed on the cover of the '311 patent is October 28, 2011. Ex. 1001 at cover. Thus, for purposes of my analysis, I assume that the time of the purported invention of the '311 patent was October 2011, and have provided an overview of the background of the relevant technology by October 2011.

4.1. Background of Touch Sensing Technology

29. The technology behind touch sensing, used for touchscreens and touchpads, dates back to the 1960s. Numerous sensing technologies have been used and many variations and enhancements have been developed over the years. In addition, innovations have been introduced in sensing circuitry, measurement and decision algorithms, and detection of motion and gestures. The term "touchscreen" is often used when touch detection occurs on or near the surface of a display device, via an overlay sensor or a sensing device surrounding the display. The term "touchpad" is often used to describe touch detection devices, including touch detection devices that are positioned on a separate part of the display surface, away from the display surface, on another portion of the device housing, or in a separate

housing. The technology for detecting and measuring touch is generally the same, allowing for the possibility that a touchpad may not be transparent. I will use the term “touchscreen” to refer to both technologies generally when there is no substantial distinction.

30. Many different types of technology have been used for touchscreens including technologies that measure light, sound, pressure, or various electrical phenomena. In general, touch sensing technologies fall into 3 general categories:

- A set of technologies that are generally referred to as "analog" technologies use light, sound, pressure, or an electrical property such as resistance or capacitance to measure the distance and/or direction from the touched location to a reference point, usually the edge of the touch surface. In general, this is done in both the X and Y axes so that a location within a rectangular area can be determined.
- Another type of technologies, often called "beam," "matrix," or "row/column" sensors use a set of detection structures such as electrodes or light beams in each of the X and Y axes. These determine which of the detection structures is being activated along each axis to locate one or more touches. Separate signals can be generated corresponding to each row or column.

- The remaining common technologies uses independent sensing zones. Sensing structures related to each zone determine if that zone is being touched. If the zones are arranged in a regular structure such as a 2-dimensional array, this is sometimes called an array-sensing technology or a pixel-sensing technology. Separate signals can be generated corresponding to each location.

31. Within each of these broad categories, there are many more variations depending on what physical phenomenon is being measured, how it is measured, how measurements are processed and converted to digital data, and what further processing is performed to filter, interpret, and/or report the resulting data. Each of these technologies has advantages and disadvantages when compared to others including variations in cost, size, power, manufacturing complexity, reliability, sensitivity, transparency, speed, and accuracy. In the time period prior to the ’311 filing, common touch-sensing technologies included:

- **Resistive sensor technologies:** These technologies use the electrical property called "resistance" to locate touch points on a touch sensor. Resistance is an alternative way of expressing the property of conductance. Resistive touch sensors were produced in analog, matrix, and pixel-array forms. One or more conductive/resistive layers were generally applied to two substrates each made of glass or plastic. The substrates could be rigid

sheets or flexible films and were separated by an insulator. Both opaque conductors such as carbon films and thin metal wires and transparent conductors such as Indium Tin Oxide (ITO), Tin Antimony Oxide (TAO), and gold were used in resistive sensors. Since resistive touchscreens respond to physical pressure, they are generally operational when the screen is directly touched or when a flexible layer, such as a protective film or the fingertip of a glove, placed on top of the touchscreen is pressed.

- **Capacitive sensor technologies:** For the purpose of understanding touch sensor design, capacitance is the ability to conduct alternating current signals. Alternating current signals can travel through air, glass, plastic, or other normally insulating materials when capacitance is present. The human body provides a measurable amount of capacitance and thus can be detected in this manner. Capacitive touch sensors were produced in analog, matrix, and pixel-array (zone capacitive) forms. Some designs used conductive electrodes placed on a single glass or plastic substrate while others used multiple substrates each containing conductive electrodes. Capacitive touchscreens can be based on measurement of self-capacitance whereby a change in the capacitance between an electrode to ground is used to detect a touch. A finger provides this type of capacitance. Other capacitive touchscreens are based on measurement of mutual

capacitance whereby a change in the capacitance between one electrode and another is detected. A finger provides this type of capacitance as well. Since capacitance can be detected through insulating materials including air, capacitive systems can measure the capacitance of a finger that is actually touching the sensor or that is simply in the proximity of the sensor. Some detection threshold must be established to determine how close a finger should be before the system considers it to be "touching" the sensor.

- **Light-beam technologies** are among the earliest touch technology system to enjoy widespread use. Generally, these are called "infrared" touch sensors since they use infrared light beams to detect a touch. A well-publicized early educational software system from the University of Illinois called PLATO used infrared touchscreens in the 1970s. Most infrared touchscreens use a matrix configuration where light emitters (infrared LEDs) are placed along the bottom and one side of the screen and infrared detectors (phototransistors or photodiodes) are placed along the top and other side. The light emitters are pulsed to shine a light across the screen. If a finger is present in between a light emitter and its corresponding detector, then the light beam is broken and a touch is detected in that row or column. Because mechanical limitations generally require some distance between the touch surface and the light sensors (such

as 0.25"), infrared touch sensors could generally detect a touch or a near touch.

- **Surface Acoustic Wave (SAW) technology** has also been used to produce commercial touchscreens since at least the early 90s. SAW technology uses a piezoelectric transducer to create an ultrasonic pulse that travels along the surface of a glass plate or other smooth surface, The ultrasonic pulse reflects off of a finger and produces a reflected sound back to the transducer. The general principle is similar to that used in a medical ultrasound machine. The distance from the transducer can be calculated from the time required for the pulse to be reflected. By using multiple transducers at, for example, the corners of the screen, the location of a touch can be determined.

- **Image-based touch sensing** uses a camera, such as a video camera, to create a pixelated image of the touch surface. Various commonly known image processing techniques can then be used to detect and /or track a finger within this image. This includes filtering, contrast enhancement, thresholding, edge detection, peak detection, shape detection, histogramming, Hough transforms, template matching, frequency-space transforms, and other known image enhancement and feature recognition techniques.

4.2. Capacitive Sensor Technologies

32. The ’311 patent relates to capacitive sensing technology. Ex. 1001 at 3:31-64. Embodiments described in the ’311 patent include both mutual capacitance sensing and self-capacitance sensing. Ex. 1001 at 3:31-64.

33. As I noted above, for the purpose of understanding touch sensor design, capacitance is the ability to conduct alternating current signals. Alternating current signals can travel through air, glass, plastic, or other normally insulating materials when capacitance is present.

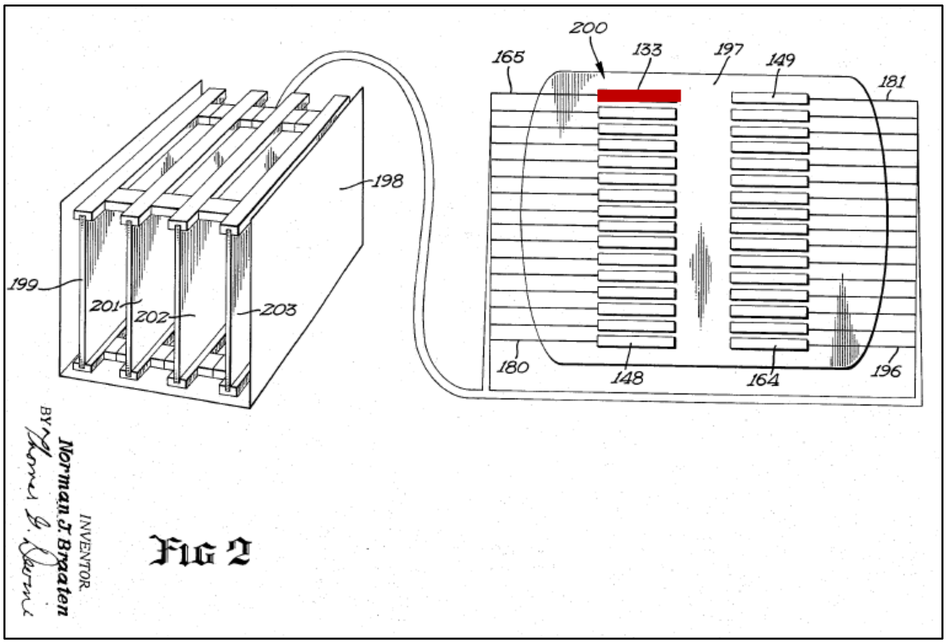
34. There are two main types of capacitance used to detect touches in touchpads and touchscreens: self-capacitance and mutual capacitance.

4.3. Self-Capacitance

35. One straightforward way in which capacitance is used to detect touch location is through the use of self-capacitive electrodes. In self-capacitance, an array of individual electrodes can be used to detect one or more touches by independently measuring the capacitance of each electrode and, if appropriate, correlating those measurements.

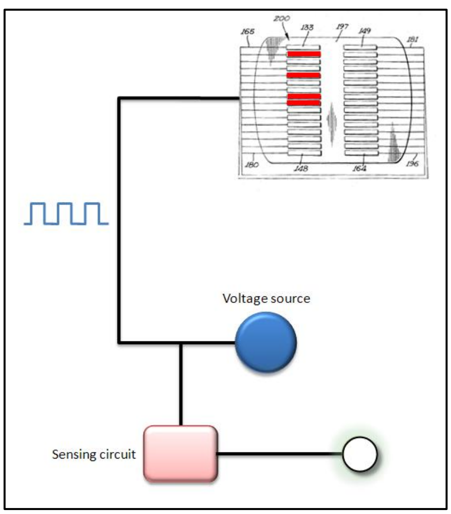
36. Self-capacitance touchscreens have been known for over forty years. For example, the figure shown below shows a self-capacitance touchscreen from a patent filed in 1970 (U.S. Patent No. 3,696,409). Each of the rectangles (e.g., 133, 149, 148, 164) is a separate electrode (I have colored one of the sensing electrodes

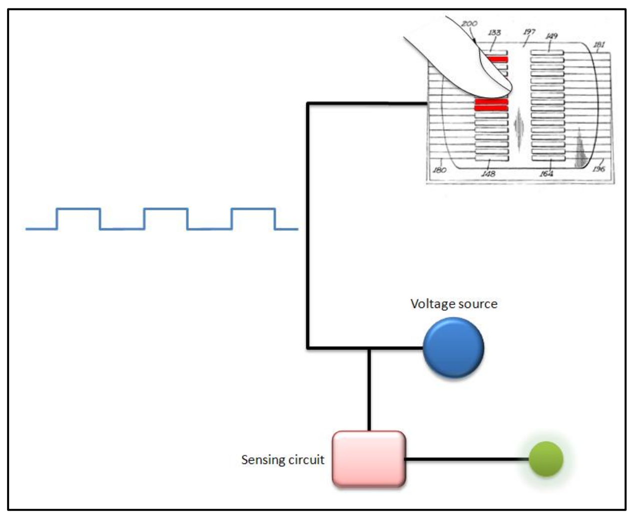
red for purposes of illustration). When a finger approaches the touch screen near one of the rectangular sense electrodes, the capacitance to ground of that electrode (and possibly other nearby electrodes) changes. This information is sent to a computer, which interprets the change in capacitance of the various electrodes to determine where in the X-Y plane of the touch screen a touch has occurred and the magnitude of that touch:



37. A fairly simple way to understand how self-capacitance is used to detect a touch is to consider a single electrode with a particular charge "q." When a grounded and conductive object such as a finger approaches this electrode, the charge on the electrode will change in the vicinity of the finger because of the finger's own conductive nature. The capacitance of this electrode can be measured with respect to ground—a measurement referred to as "self-capacitance"—to indicate the

proximity of the finger to the electrode. Because the location of the electrode is known, the capacitance measured at this electrode provides information regarding the proximity of a finger at a known location. A touch sensor can be constructed using an array of these self-capacitive electrodes. Independent measurements of capacitance at each electrode in the array will provide information regarding touch location throughout the array. An example of a self-capacitive sensing circuit based on the electrode configurations shown above appears below. As illustrated below, the presence of a finger changes the signal received from the sense electrodes.





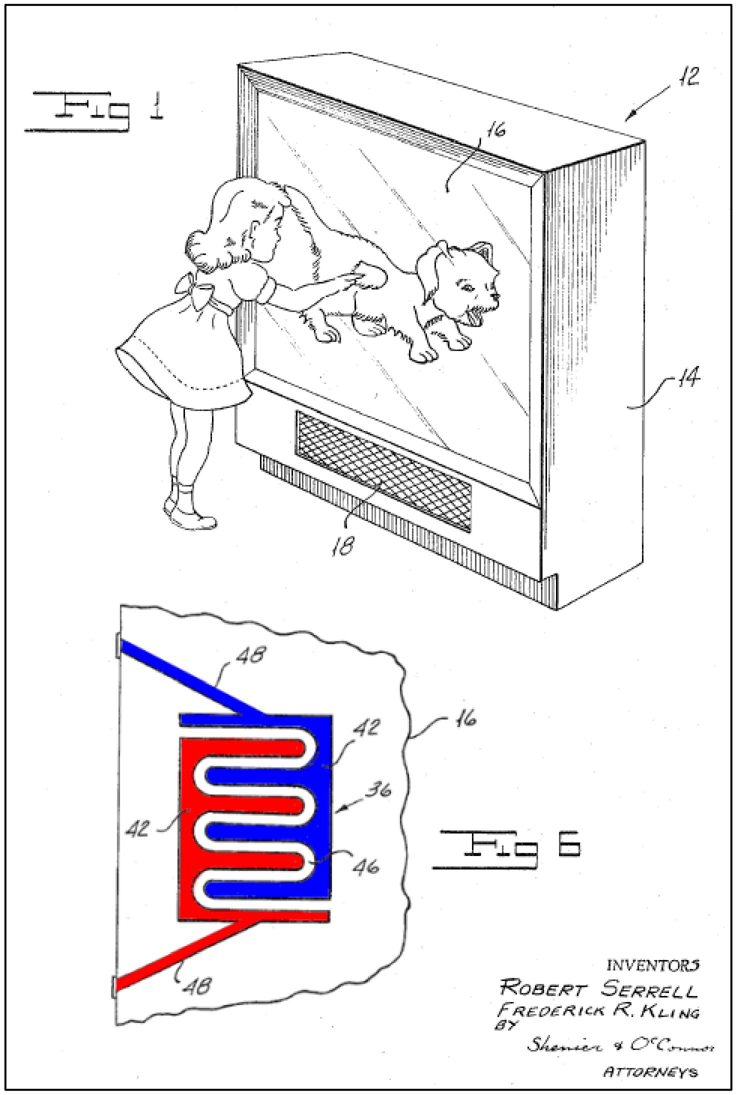
38. A self-capacitive touch sensor can be made transparent by constructing the sense electrodes from a transparent conductor such as indium tin oxide (ITO) or antimony tin oxide (ATO) or by using thin conductors that cannot be readily seen with the eye. ITO and ATO are thin-film oxides that conduct electricity but can be applied thinly enough so that they are transparent. Using transparent conductors such as ITO and ATO to create transparent electrodes has been known in the art for

decades. For example, I regularly used ITO and ATO to create transparent touchscreens throughout the 1980s. Similarly, using thin copper, silver, or gold wires has been used for many years when such wires would be hidden or small enough to not be seen.

4.4. Mutual Capacitance

39. Another type of capacitive touch sensor uses mutual capacitance to detect touches. The same basic electrical principle—capacitance—is used to detect touches in a mutual capacitance touch sensor as in a self-capacitance touch sensor, except that in a mutual capacitance touch sensor, touches are measured using changes in the capacitance measured between two electrodes (as opposed to changes in capacitance of a single electrode measured with respect to ground).

40. Like self-capacitance touchscreens, mutual capacitance touchscreens have been known for decades. For example, the figure shown below shows a transparent mutual capacitance touchscreen from a patent filed in 1965 (U.S. Patent No. 3,382,588). The red and blue shapes are separate electrodes. The blue electrode is driven, and the red electrode is sensed:



41. When the blue electrode is driven with a voltage, the electric field from the driven electrode draws charge to those portions of the red sense electrode nearby the blue drive electrode.[1] When a finger approaches the touch screen near a sense

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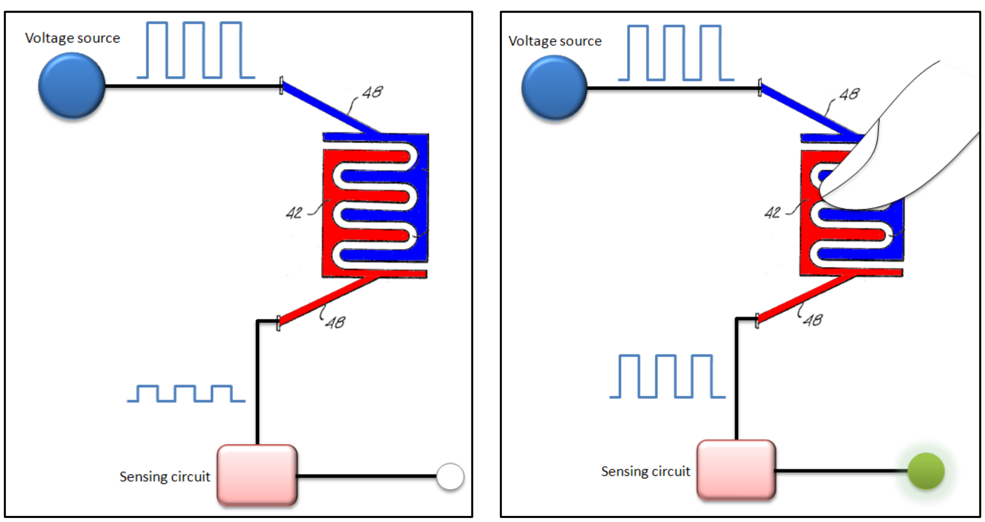
[1] The "increased" charge on the sense electrode does not come from the drive electrode itself, but from elsewhere in the sensing circuit. One way to understand the interaction of drive and sense electrodes in a mutual capacitance sensor is to think of charge on the sense electrode as being "rearranged" by the electric field from the drive electrode, so that electrons on the sense electrode cluster near the drive electrode. The total number of electrons on the sense electrode may increase

electrode in a mutual capacitance touch screen, the amount of charge on the sense electrode near the finger changes even further, thus changing the mutual capacitance between the drive and sense electrode. This information is sent to a computer, which combines information regarding the change in capacitance of the sense electrodes over time with information regarding voltage applied to the drive electrodes over time to determine where in the X-Y plane of the touch screen a touch has occurred and the magnitude of that touch. The illustrations below show the circuitry of a mutual capacitance touch sensor using the electrode configuration shown above. As shown below, the presence of a finger changes the mutual capacitance between the drive and sense electrodes and thereby changes the signal received from the sense electrode, allowing a touch to be detected.



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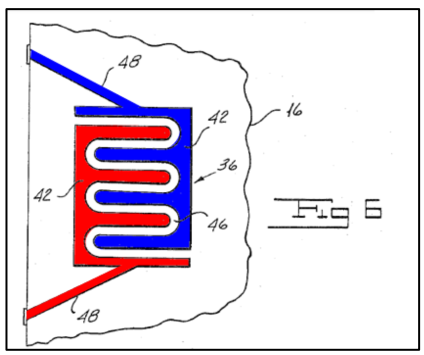
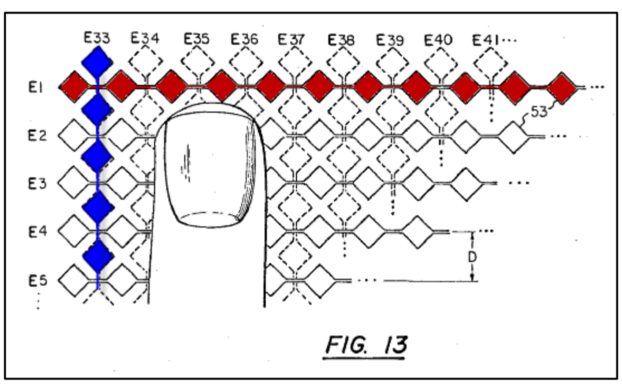
due to the electric field from the drive electrode, but these electrons travel from elsewhere in the sense circuitry (e.g., a touch sensor integrated chip).

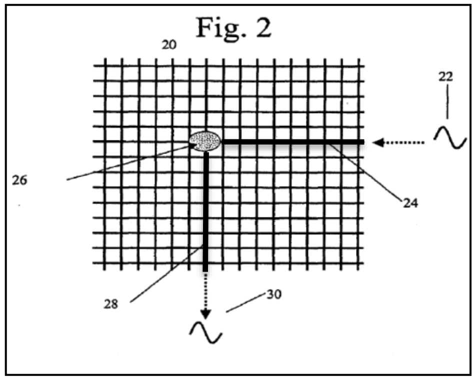
42. Mutual capacitance touch sensors can have a variety of configurations of drive and sense electrodes. In fact, virtually any imaginable geometric pattern of drive and sense electrodes can be used to detect touches using mutual capacitance (the effectiveness of these configurations in sensing touch will, however, vary greatly depending on the electrode pattern used). All that is required for mutual capacitance to exist between a drive and sense electrode is for the drive and sense electrodes to be situated close to one another but not electrically connected. For example, the following electrode patterns could be (and have been) used to sense mutual capacitance:



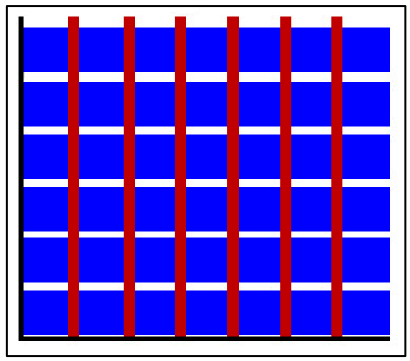
U.S. Pat. No. 3,382,588 (filed Jan. 11, 1965)



U.S. Pat. No. 4,733,222 (filed Apr. 18, 1986)



U.S. Pat. No. 7,372,455 (filed Jan. 15, 2004)



U.S. Pat. No. 5,565,658 (filed Dec. 7, 1994)

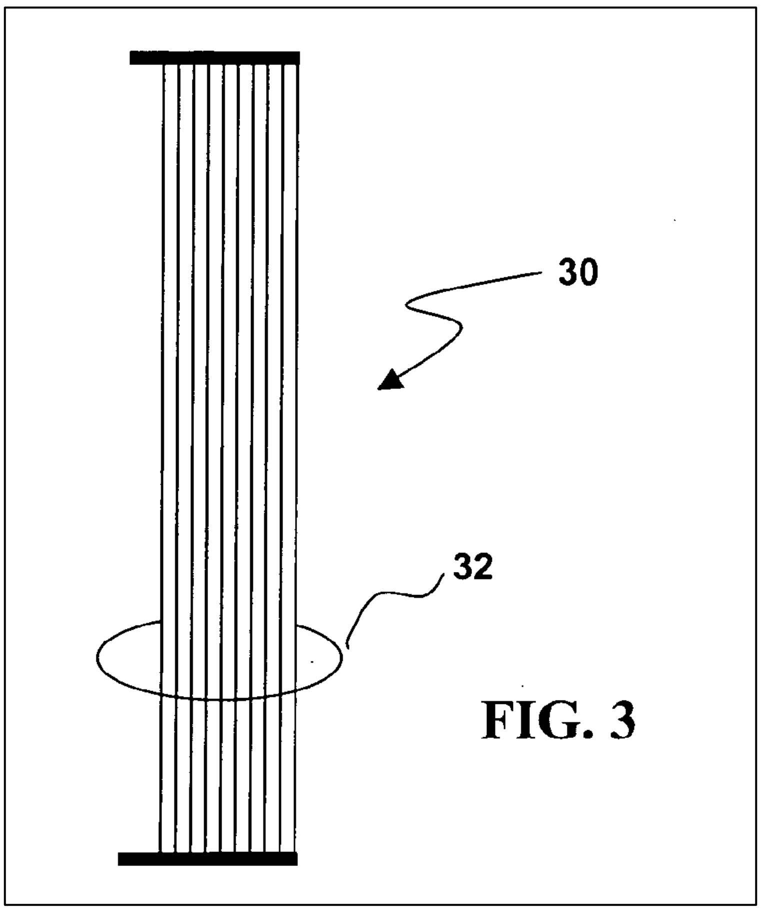
43. The simplest way in which to construct a high-resolution mutual capacitance touch panel is to create a two-dimensional "matrix" array of drive and sense electrodes on two layers, separated by a dielectric insulator such as glass or thin plastic. The grid-like mutual capacitance sensors shown above from U.S. Patent Nos. 4,733,222, 5,565,658, and 7,372,455 all show variations of two-layer mutual capacitance sensors in which the drive and sense electrodes are arrayed in a grid-like matrix. In these types of sensors, the drive electrodes can be on the bottom (away from the user) or on the top (near the user) of the sensor. Both variations appear throughout the prior art.

44. As with a self-capacitive touch sensor, a mutual capacitance touch sensor can be made transparent by constructing the electrodes from a transparent conductor such as indium tin oxide (ITO) or antimony tin oxide (ATO) or with a pattern of thin wires. The dielectric insulator between electrode layers must also be transparent, and a common transparent insulator such as glass or clear plastic can be used for this insulator layer. Using transparent electrodes in mutual capacitance touch sensors has been known in the art for decades. For example, U.S. Patent No. 3,382,588, discussed earlier, discloses a mutual capacitance touch sensor with "two coplanar transparent glass electrically conducting plates separated by an insulating gap." U.S. Patent No. 3,382,588 at claim 2.

4.5. "Grid" or "Mesh" Electrodes in Capacitive Sensors

45. As I have discussed above in Sections 4.3 and 4.4, using transparent conductors such as ITO and ATO to create transparent electrodes has been known in the art for decades. Additionally, however, thin, opaque wires have also traditionally been used to create touch-sensing conductors while maintaining the visibility of an underlying touchscreen. Even though the individual wires may be opaque, each individual wire is so small that a grid or mesh made up of such wires still appears to be effectively transparent to a viewer, in the same way that a screen door or window screen in your house could be effectively transparent to the eye.

46. For example, a 1977 paper by B. Stumpe at CERN (*A New Principle for an X-Y Touch Screen*) described the use of 80µ wires to construct a sufficiently-transparent X-Y grid for a touch screen sensor. U.S. Patent Application Publication 2007/0018076 (filed by IPO Displays Corp. in 2006) described (at paragraph [0029]) a touchscreen sensor comprised of conductive wires on the order of about 500nm to 500µ in width:



U.S. Patent Application 2007/0018076 at Figure 3.

47. Another mutual-capacitive touchscreen using a grid of thin copper wires is disclosed in a published paper by Sony researcher Jun Rekimoto in 2002,

Smartskin: An Infrastructure for Freehand Manipulation on Interactive Surfaces, CHI '02: Proceedings of the SIGCHI conference on Human factors in computing systems: Changing our world, changing ourselves. (Ex. 1022). The use of a copper mesh allows for a flexible screen. Rekimoto explains:

> "This paper introduces a new sensing architecture, called Smart-Skin, which is based on capacitive sensing (Figure 1). Our sensor accurately tracks the position of the user's hands (in two dimensions) and also calculates the distance from the hands to the surface. It is constructed by laying a mesh of transmitter/receiver electrodes (such as copper wires) on the surface. As a result, the interactive surface can be large, thin, or even flexible." Ex. 1022 at 1.

48. The Smartskin design utilized this copper mesh and a mutual-capacitance detection circuit to allow detection of multiple touches and multi-touch gestures. An illustration of a prototype is shown below:

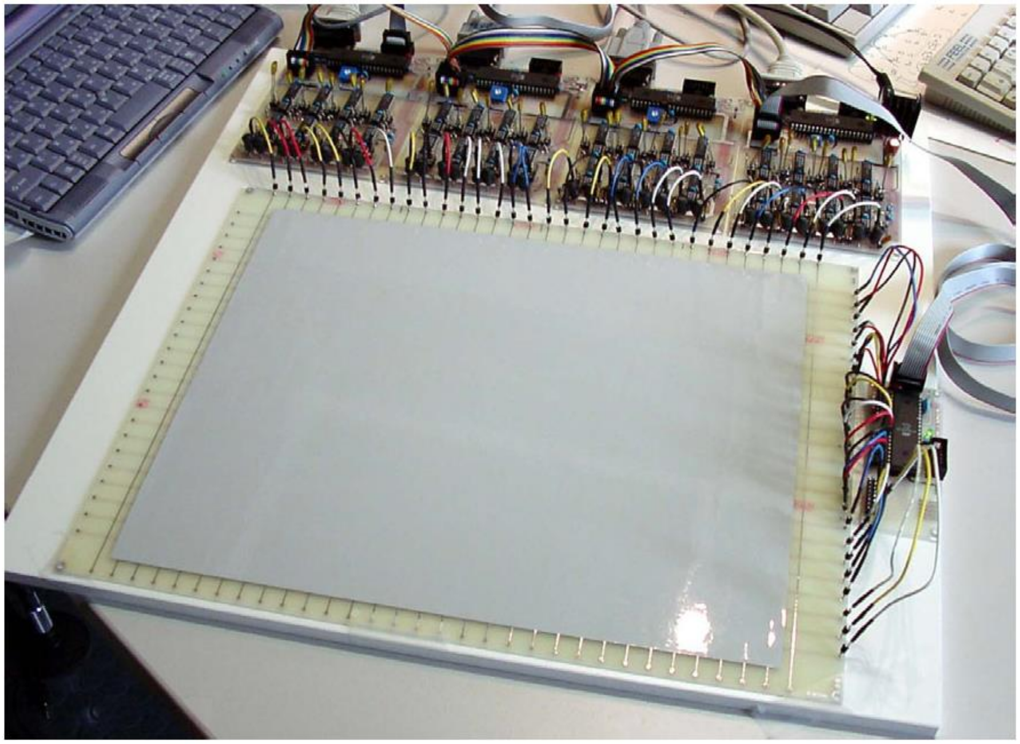


Figure 9: A gesture-recognition pad made up of a 32×24 grid mesh. A sheet of plastic insulating film covers Sensor electrodes.

Ex. 1022 at Fig. 9.

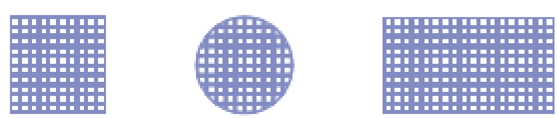
49. A number of patents and patent applications by Atmel Corporation (the applicant for the ’311 patent) had similarly disclosed touchscreens using thin (but opaque) metal wires to create effectively-transparent touchscreen sensors well before the application that led to the ’311 patent was filed on October 28, 2011.

50. For example, U.S. Patent Application Publication No. 2010/0045632 (“Yilmaz”) an Atmel application that shared the first named inventor (Esat Yilmaz) with the ’311 patent, disclosed a capacitive touch sensor in which “each drive and/or

sense electrode is made of a mesh or filigree pattern of interconnected lines of highly conductive material which collectively define each electrode," where "the interconnected lines preferably have a sufficiently small width so as to be invisible or almost invisible." Ex. 1010 at ¶ [0022]. This allows the mesh to be "made of material that is not inherently invisible, e.g. a metal such as copper, but still remain practically invisible." Ex. 1010 at ¶ [0022].

51. Other Atmel publications similarly had discussed the use of conventional mesh electrodes well before the October 2011 filing of the application that led to the '311 patent. In fact, Atmel published a "Touch Sensors Design Guide" in September 2009 (two years before the filing of the '311 patent) that disclosed "mesh" electrodes on a substrate to create a capacitive touch sensor:

Figure 3-3. Electrodes with 50 Percent Mesh Fills



Ex. 1011 at Fig. 3-3.

52. Similarly, U.S. Patent Application Publication No. US 2010/0123670, filed by Atmel Corporation on April 10, 2009 (and published on May 20, 2010) and listing Harald Philipp as a named inventor, disclosed "electrodes arranged in a mesh pattern on a substrate. Each electrode is formed by interconnected metal traces, the metal being intrinsically opaque, but the metal traces being sufficiently narrow as to

be practically invisible." Ex. 1012 at abstract. The patent application notes that metals such as copper or silver can be used to form these "mesh" electrodes, which are "malleable" and "can be readily flexed or kinked without damage." Ex. 1012 at ¶¶ [0008]-[0009].

53. The use of "mesh" electrodes in capacitive touch sensors was also described in a series of patents and patent applications filed by 3M in the years before the filing of the application that led to the '311 patent. U.S. Patent Application Publication No. 20090219257 to Frey et al.[2] ("Frey I"), filed in February 2009, disclosed "electrically conductive micropatterns" made up of conductive wires as small as 0.5 microns (and made as metals such as silver or copper) that are patterned in various ways to create touch sensor conductors and noise shields for use in capacitive sensors with advantageous properties related to design, manufacturing, cost, and appearance. "Fig. 15 illustrates the conductor micropattern for one embodiment of the touch screen sensor":

---

[2] I note that this application eventually issued as U.S. Patent No. 8,179,381, which was cited by the Examiner of the '311 patent in rejections during prosecution of the '311 patent, as discussed in more detail below.

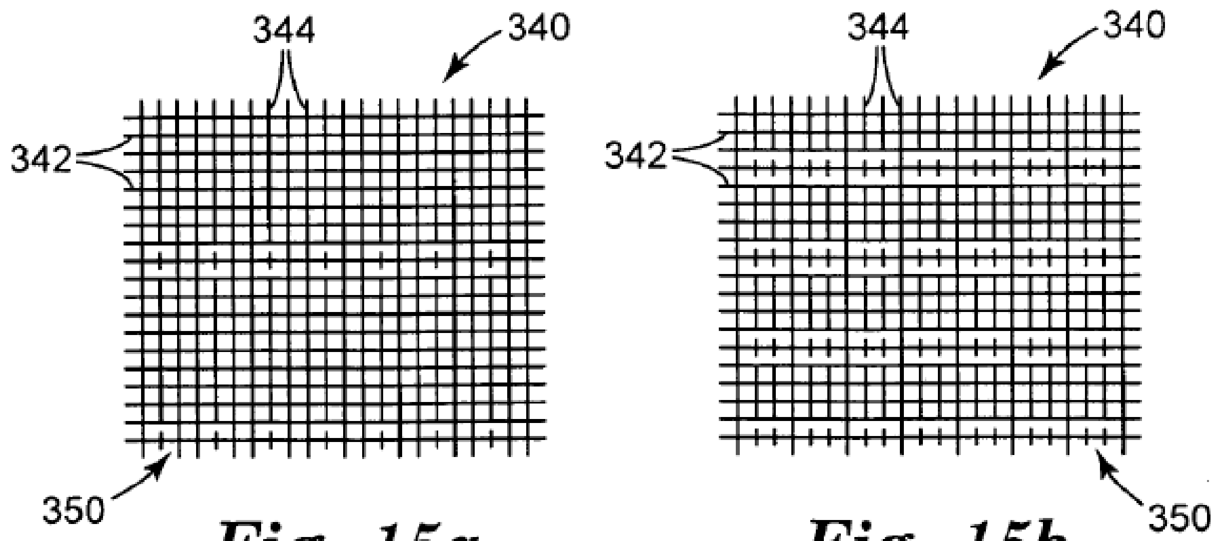
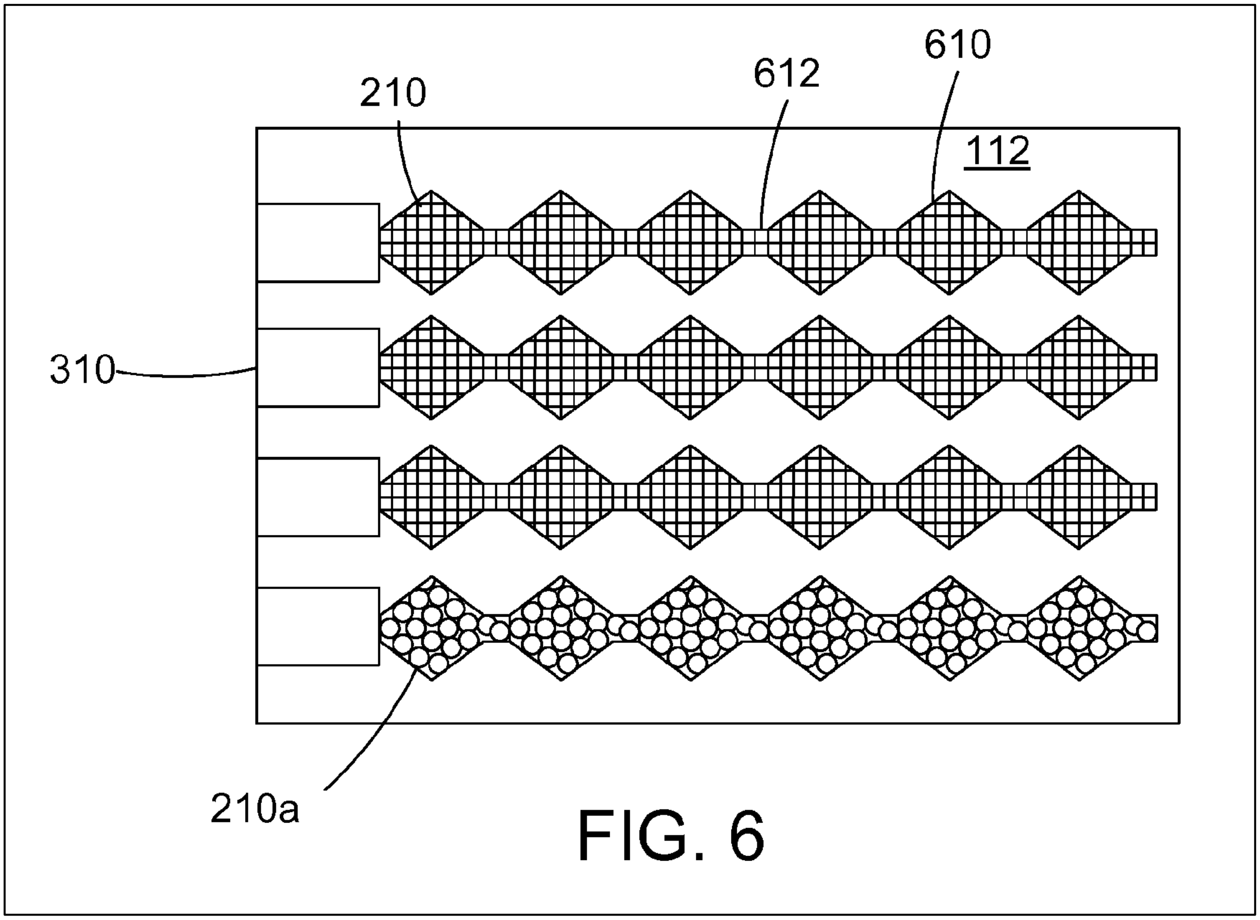


Fig. 15a　　*Fig. 15b*

Ex. 1013 at Figs. 15a/15b.

54. U.S. Patent Application No. 2010/0156840 to Frey et al. ("Frey II") (Ex. 1014), also filed in February 2009, shared a similar disclosure to Frey I and similarly disclosed such "electrically conductive micropatterns."

55. Other patents and publications similarly disclosed mesh electrodes in the years leading up to October 2011. For example, U.S. Patent Application Publication No. 2011/0007011, filed by Ocular LCD Inc. in June 2010, disclosed various examples of "mesh electrode" designs using various geometric shapes of conductive lines (Ex. 1020 at ¶ [0027]):



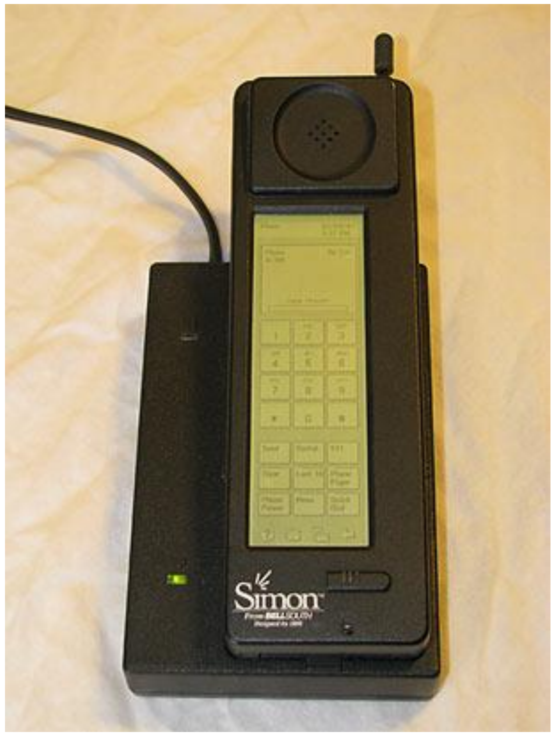
Ex. 1020 at Fig. 6.

4.6. Touchscreen Systems

56. Using a touchscreen overlaid on an LCD has been well known since at least the late 1980s. In 1985, I developed the sensor technology for what I believe to be the first commercial keyboardless tablet-style computer, the Linus Write-Top. While the commercial product used a pen-based input sensor that I developed, earlier versions of the product used a conventional touchscreen. Both embodiments are discussed in a patent related to this device, U.S. Patent 4,972,496. The Linus Write-Top is illustrated below. The Linus Write-Top could

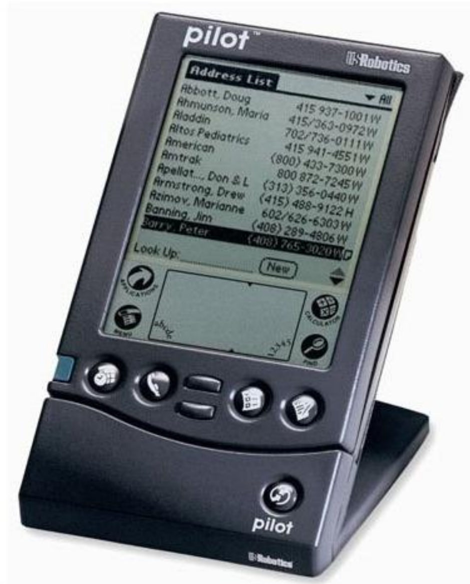
resolve over 1 million distinct touch locations and measure movement every 5-10ms, as described in U.S. Patent 4,972,496:

57. Similar touchscreens were used in smaller devices as well. The IBM/BellSouth Simon mobile phone used a touchscreen over an LCD and was first shown in 1992. *See* Peter Ha, "All-TIME 100 Gadgets: BellSouth Simon," *Time Magazine* (Oct. 25, 2010); Chris O'Malley, "Simonizing the PDA," *Byte Magazine* 145-148 (Dec. 1994). I personally developed touchscreen prototypes for the IBM Simon. The Simon device is illustrated below.

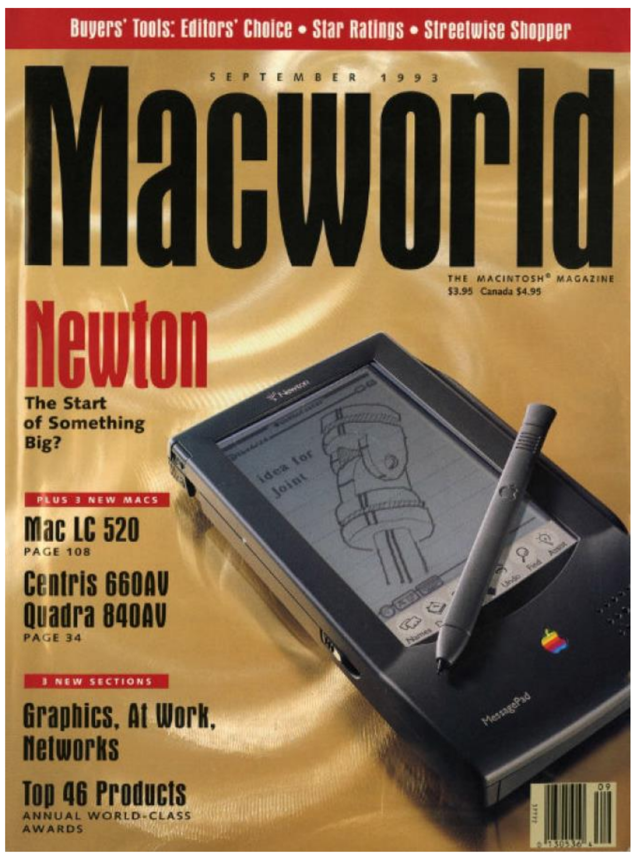


58. In 1993, AT&T introduced the EO 440 and EO 880 tablet computers which included an optional cellular phone module. These devices used the PenPoint operating system. The EO was controlled though a tablet-style pen-sensitive display. By moving the pen on the screen in a particular direction (up, down, left, or right) as a gesture, the data presented in certain screens would scroll in response. The EO 440 device is illustrated below.

59. The Apple Newton and the Pilot 1000 (later called the Palm Pilot) were also introduced in the early and mid-90s. These devices were personal organizers that also used touchscreens over an LCD display for user input and to control the user interface.



(Ha – Palm Pilot.)

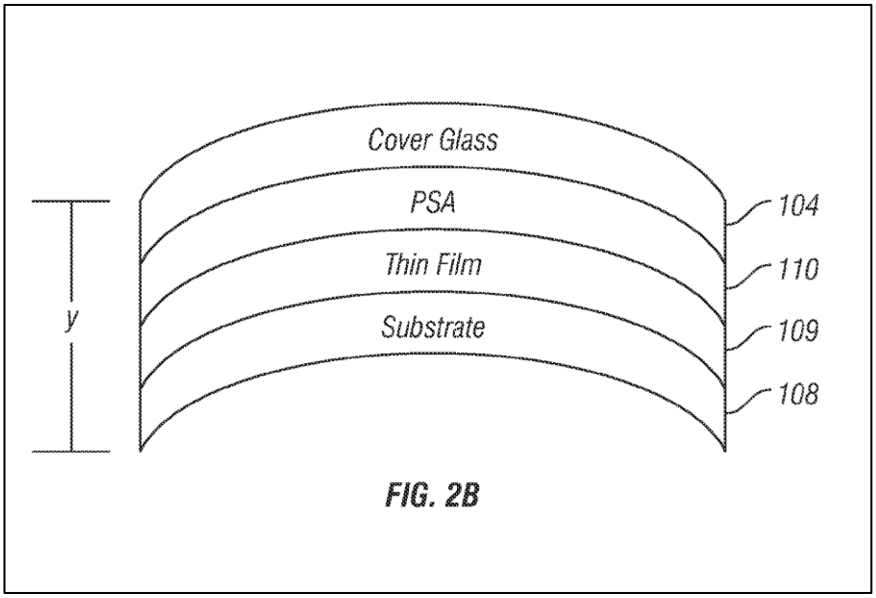


(1993 Macworld.)

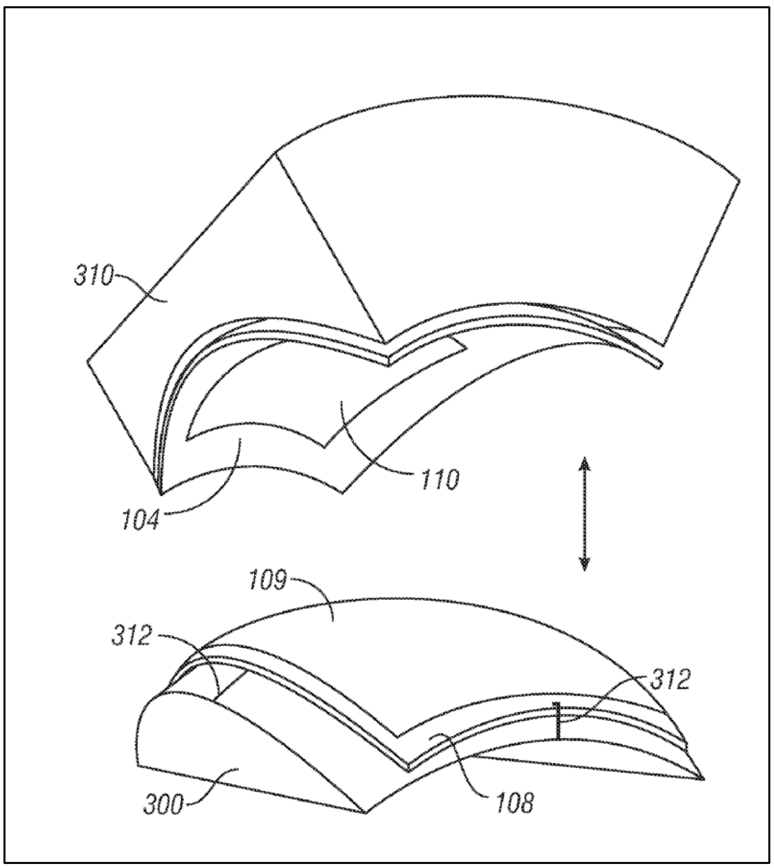
4.7. Curved Touch Panels

60. Curved touch panels date back at least to the early 1980s when I started working in the touchscreen industry. Since ordinary televisions and computer monitors were curved (either spherical or cylindrical), most touch sensors were as well. The sensor illustrated below is typical of what was used at the time:

61. A more modern curved touch sensor design is illustrated in U.S. Patent Application 2012/0111479, filed by Apple on Nov. 5, 2010 ("Sung") (Ex. 1021). This application discloses the use of flexible materials that can be molded to fit a curved surface. Ex. 1021 at ¶ [0008]. This can be used as a capacitive sensing surface. Ex. 1021 at ¶ [0021]. The sensing conductors can be ITO or "non-transparent conductive materials, such as silver ink, copper, SiO, or the like." Ex. 1021 at ¶ [0022]. A matrix of conductors can be used for mutual capacitive sensing. Ex. 1021 at ¶ [0023].



Ex. 1021 at Fig. 2B



Ex. 1021 at Fig. 3A

62. Another Apple patent publication, U.S. Patent No. 9,400,576 ("Chen") (Ex. 1015) (filed by Apple in July 2011) similarly disclosed a curved touch sensor design. Chen taught the use of "diamond-shaped mesh electrodes," as described at 8:49-63 of Chen and as shown by Fig. 14:

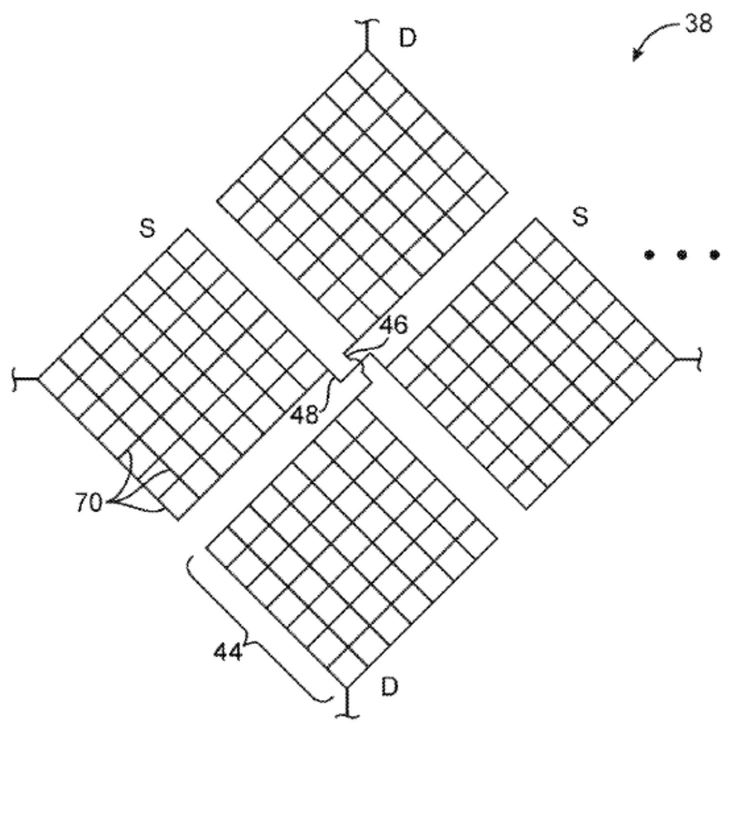


FIG. 14

63. Chen disclosed that these mesh electrodes (which "may be formed from metals such as copper, aluminum gold, etc.," Ex. 1015 at 6:5-18) can be used to create a touchscreen display 14 ("an OLED display with integrated touch sensors) that is folded over the side of a device to create active display portions both on the front surface of the device as well as on the sidewalls, which can be used to display

touch-sensitive "virtual buttons" to the user on the sidewalls of the device. Ex. 1015 at 13:23-14:8. These virtual buttons are represented by VB in Fig. 34 of Chen:

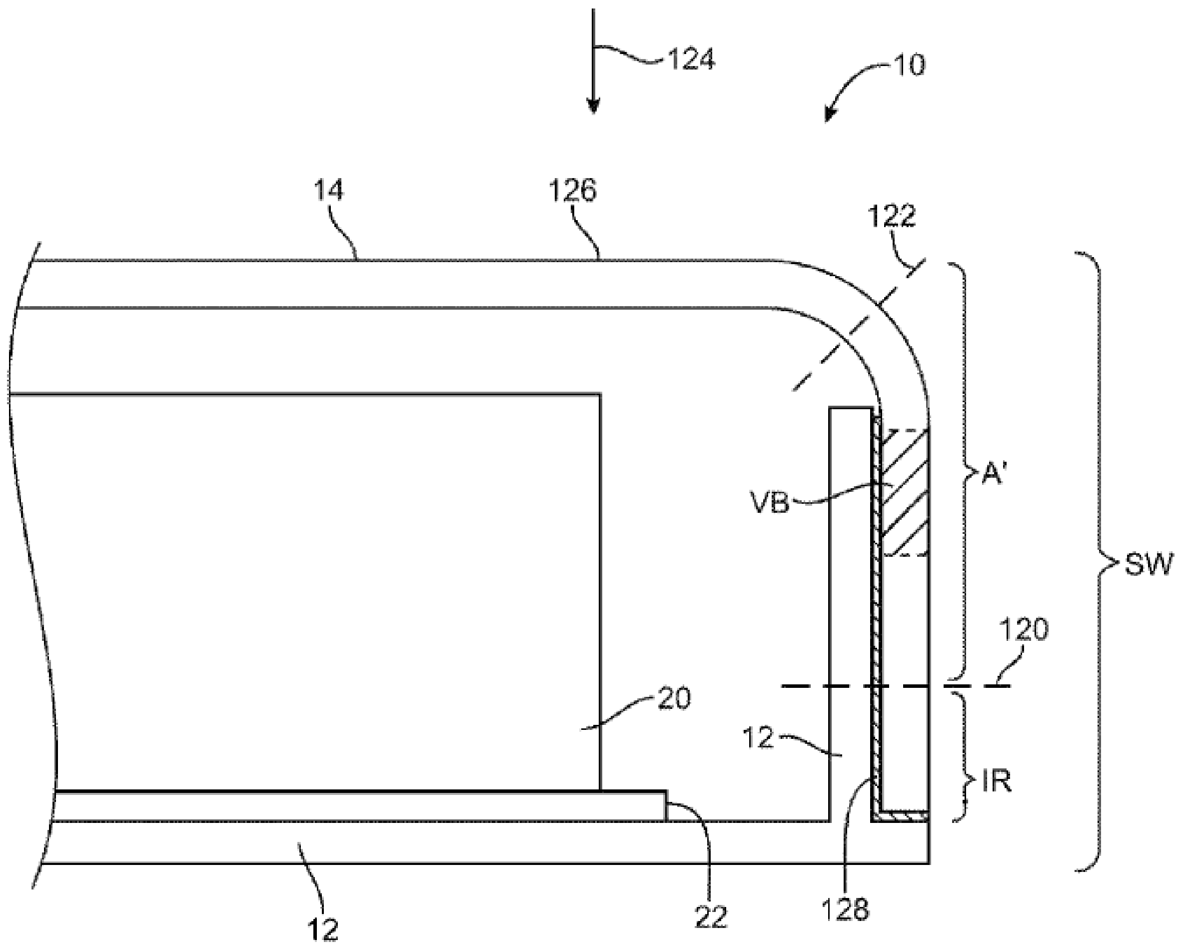


FIG. 34

64. Other publications similarly disclosed curved touch panels that could be used to create touch-sensitive displays on both the front and sides of a device. For example, International Publication No. WO 2011/107665 ("Brown"), filed in March 2011, disclosed a "touch sensitive film" which could be formed onto both the front and sides of a mobile phone to "replace[] the function of any mechanical

buttons or switches used in prior art mobile phones," which would result in "technically improved functions" and "simplify and ameliorate the appearance of e.g. mobile phones." Ex. 1016 at 22:16-23:12. Brown illustrated such a "conformal and electrically conductive" touch-sensitive film in Fig. 6:

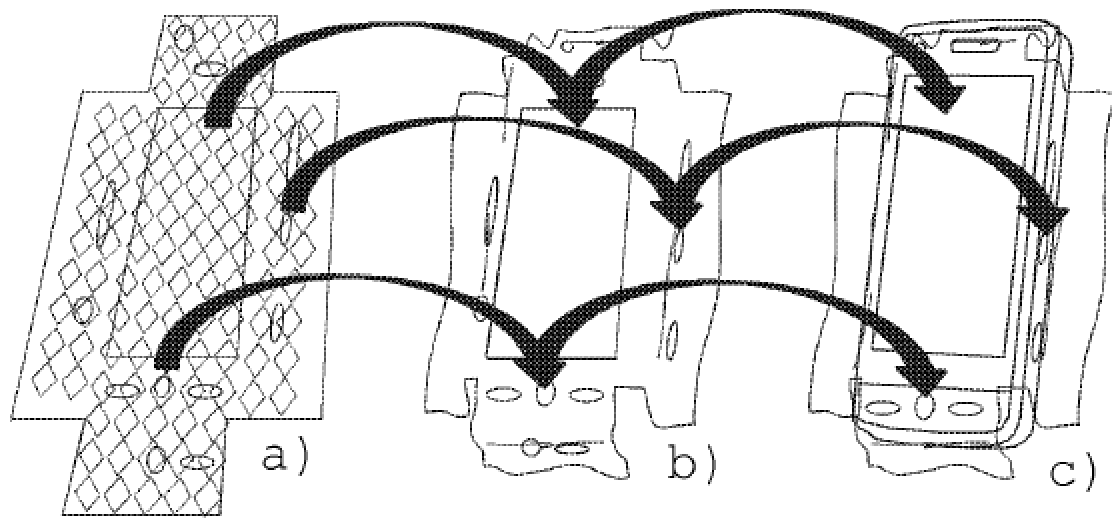


Fig. 6

5. OVERVIEW OF U.S. PATENT 9,256,311

5.1. Summary

65. The cover of the '311 patent states that the '311 patent is entitled "Flexible Touch Sensor," and that its filing date was October 28, 2011. Ex. 1001 at cover. In a section entitled "TECHNICAL FIELD," the '311 patent states that it "generally relates to touch sensors. Ex. 1001 at 1:5. As I have explained above, by the October 2011 filing date of the '311 patent, the use of "touch sensors," particularly in touchscreens, was well-known in a variety of different devices. The

"BACKGROUND" section of the '311 patent acknowledges this, noting that by that time touch sensors were known to be used in "a desktop computer, laptop computer, tablet computer, personal digital assistant (PDA), smartphone, satellite navigation device, portable media player, portable game console, kiosk computer, point-of-sale device, or other suitable device." Ex. 1001 at 1:15-23.

66. The '311 patent also acknowledges that there are a number of different types of touch sensor, as I have described above. However, the '311 patent is mainly directed towards one specific type—"the capacitive touch screen." Ex. 1001 at 1:24-33. As I have noted above, capacitive touch screens (and the touch sensors incorporated within) were well known to those in the art by October 2011. The '311 patent provides a description of the elements that made up a typical capacitive touch sensor—conductive electrodes "disposed on one or more substrates, which may be made of a dielectric material." Ex. 1001 at 1:59-62.

67. In such conventional capacitive electrodes, the '311 patent explains that one electrode can serve as a "drive" electrode, with another electrode serving as a "sense" electrode, and that a pair of "a drive electrode and a sense electrode may form a capacitive node," where "the drive and sense electrodes forming the capacitive node may come near each other, but not make electrical contact with each other." Ex. 1001 at 3:31-37. When "a pulsed or alternating voltage" is "applied to the drive electrode" by a controller, a charge is then induced on the sense electrode

in the capacitive node, and "the amount of charge induced may be susceptible to external influence"—specifically, "a touch or the proximity of an object." Ex. 1001 at 3:38-43. In other words, in a capacitive touchscreen, when a user's finger (or another object, such as a stylus) "touches or comes within proximity of the capacitive node, a change in capacitance may occur at the capacitive node," and the controller of the device "may measure the change in capacitance," allowing the device to determine "the position of the touch or proximity within the touch-sensitive area(s) of touch sensor." Ex. 1001 at 3:44-50.

68. The '311 patent describes a particular structure for the electrodes described above: "mesh patterns," in which "fine lines 22A-B of metal or other conductive material occupy the area of the electrode shape in a hatched, mesh, or other suitable pattern." Ex. 1001 at 5:56-6:30; 2:15-20. The '311 patent displays examples of these "mesh" electrodes in Figs. 2A and 2B, in which the patterns are formed from "intersections between lines of conductive material," Ex. 1001 at 5:67-6:3, 6:24-27:

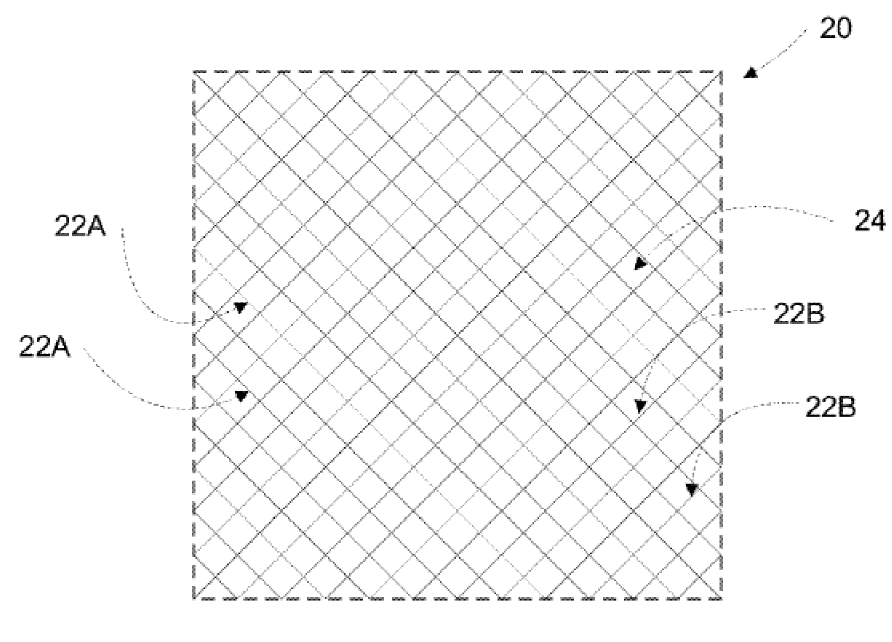


Figure 2A

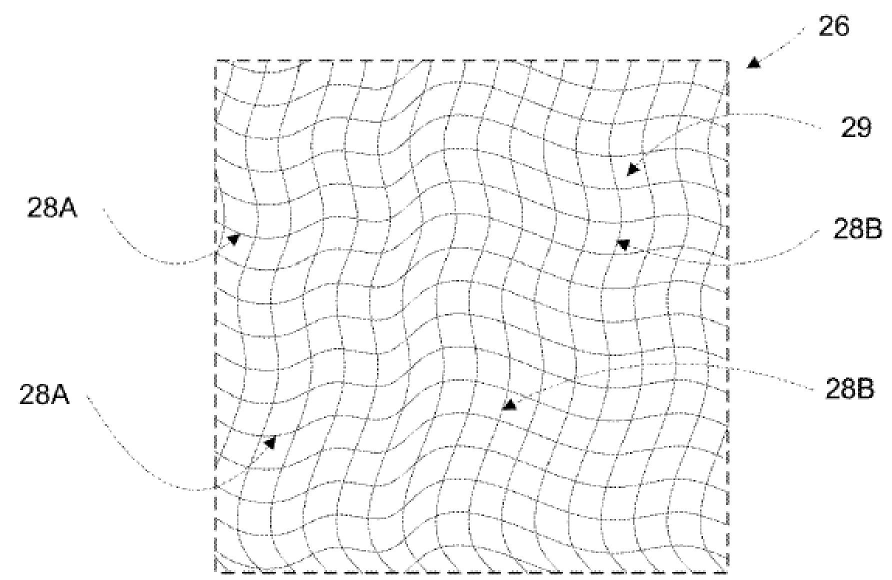


Figure 2B

69. Even though the conductive metal lines of these patterns are opaque, the ’311 patent explains that “approximately 90% or higher” of all light still gets through the pattern, because the thinness of the conductive lines means that the “total

line density is less than approximately 10% of a surface area" of the electrodes. Ex. 1001 at 6:3-13. Accordingly, even when these mesh electrodes are laid over a display, a user is still able to view that underlying display "through . . . the electrode pattern disposed on" a similarly transparent substrate. Ex. 1001 at 8:3-7. However, because approximately 10% of light is blocked by each electrode, areas of the display covered by electrodes would appear visibly distinct to a user of the touchscreen in comparison to areas that were not covered by electrodes. To avoid the user being aware of these "optical discontinuities," the '311 patent suggests "filling in" areas of the touchscreen between the electrodes with "electrically isolated" pieces of mesh, which allows the screen to appear visually consistent to a user of a touchscreen device.

70. As noted above, the '311 patent repeatedly describes the electrodes of its capacitive touch sensors "may be made of fine lines of metal or other conductive material. Ex. 1001 at 2:15-18; 2:45-47; 5:28-32; 5:57-62; 7:44-47. The patent also repeatedly gives two different examples of the type of metal that can be used to create these "mesh" electrodes: copper and silver. Ex. 1001 at 2:15-18; 2:47-54; 5:29-34; 5:57-62; 7:44-47. For the substrate that the touch sensor electrodes are layered on, the '311 patent provides a single exemplary material: "polyethylene terephthalate (PET)." Ex. 1001 at 2:39-41; 3:1-4.

71. Near the end of the ’311 patent, it contains two paragraphs describing “an example mobile telephone that incorporates a flexible touch-sensitive apparatus,” as displayed in Fig. 7, Ex. 1001 at 8:37-9:10:

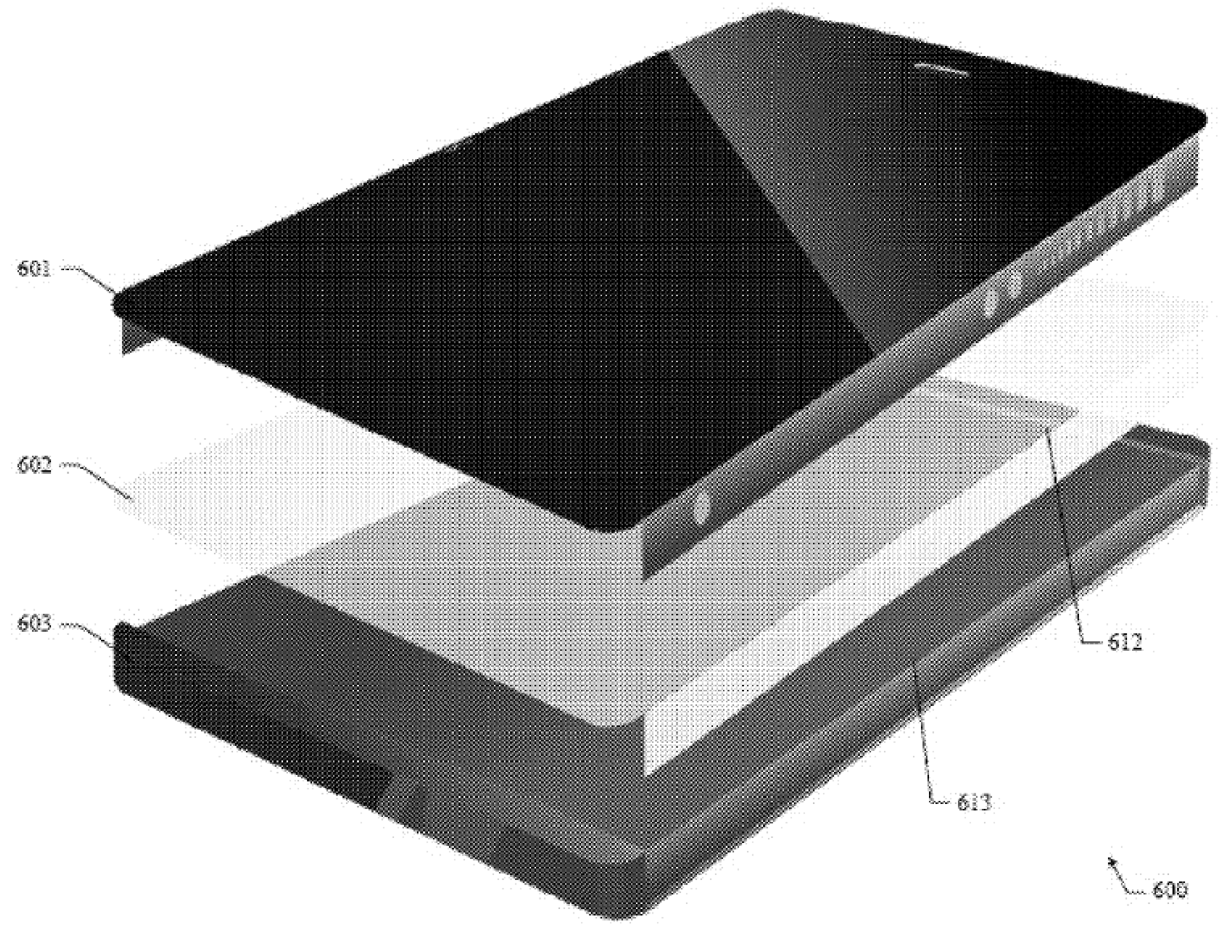


Figure 7

72. The ’311 patent describes how this “example mobile telephone 600 incorporates a touch-sensitive apparatus 612 wrapped around an example display 613.” Ex. 1001 at 7:37-41. The “electrode pattern of touch-sensitive apparatus” 612 can be “made from metal-mesh technology with a copper, silver, or other suitable metal mesh” such as those previously described in the ’311 patent. Ex. 1001 at 7:44-

47. The "substrate 602 and the conductive material of the electrode pattern may be flexible," which allows the touch sensor "to wrap around an edge 603 of example mobile phone 600." Ex. 1001 at 7:48-56. The "display 613" of this example mobile phone "may be a liquid crystal display (LCD), a light-emitting diode (LED) display, an LED-backlight LCD, or other suitable display and may be visible through cover panel 601 and substrate 602, as well as the electrode pattern disposed on substrate 602." Ex. 1001 at 8:3-7.

5.2. Prosecution History

73. I have reviewed the prosecution history of the application that led to the '311 patent, Application No. 13/284,674, which I will refer to as "the '674 application." When the '674 application was originally filed, it contained claims for an "apparatus" and a "device," each requiring "a substantially flexible substrate" and "a touch sensor disposed on the substantially flexible substrate, the touch sensor comprising drive or sense electrodes made of flexible conductive material configured to bend with the substantially flexible substrate." Ex. 1002 at 503-505 (October 28, 2011 Original Claims). The Examiner rejected these originally filed claims as obvious over the prior art. Ex. 1002 at 280-295 (November 7, 2013 Non-Final Rejection).

74. In response to the Examiner's rejection, the applicants for the '311 patent repeatedly amended the claims of the '674 application to add additional claim

limitations directed to the concept of "mesh" or "grid" electrodes that I have discussed extensively above. First, the applicants added the limitation "wherein the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection." Ex. 1002 at 218-229 (June 26, 2014 Amendment). These claims were also rejected over the prior art as obvious. Ex. 1002 at 178-196 (July 15, 2014 Non-Final Rejection). Next, the applicants added the limitation that the electrode lines "form a mesh grid." Ex. 1002 at 113-122 (March 3, 2015 Amendment). But these claims were also rejected as obvious—this time, over the Frey I publication discussed above, which the Examiner cited as disclosing mesh electrodes for a touch sensor. Ex. 1002 at 68-85 (March 19, 2015 Non-Final Rejection) (discussing "the mesh bars from the touch screen sensor taught by Frey").

75. Finally, in response to this obviousness rejection over Frey I, the applicants amended the claims of the '674 application to require that "the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display." Ex. 1002, 54-64 (June 19, 2015 Amendment). In response to this amendment, the Examiner finally allowed the claims of the '674 application, and noted that the Examiner was not aware of any prior art that taught the "wrap around one or more edges of a display" limitation that had been added to

the claims of the ’674 application. Ex. 1002 at 20-23 (September 24, 2015 Notice of Allowability).

5.3. The Claims at Issue

76. Claims 1-20 read as follows:

> 1. An apparatus comprising: a substantially flexible substrate; and a touch sensor disposed on the substantially flexible substrate, the touch sensor comprising drive or sense electrodes made of flexible conductive material configured to bend with the substantially flexible substrate, wherein: the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection to form a mesh grid; and the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display.
>
> 2. The apparatus of claim 1, wherein the touch sensor further comprises tracking disposed on the substantially flexible substrate configured to provide drive or sense connections to or from the drive or sense electrodes and configured to bend with the substantially flexible substrate.
>
> 3. The apparatus of claim 1, wherein the first and second conductive lines are made from one of carbon nanotubes, copper, silver, a copper-based material, or a silver-based material.

4. The apparatus of claim 1, wherein the touch sensor comprises: a single-layer configuration with drive and sense electrodes disposed only on a first surface of the substantially flexible substrate; or a two-layer configuration with drive electrodes disposed on the first surface of the substantially flexible substrate and sense electrodes disposed on a second surface of the substrate opposite the first surface.

5. The apparatus of claim 1, wherein the touch sensor is a mutual-capacitance touch sensor or a self-capacitance touch sensor.

6. The apparatus of claim 1, wherein the touch sensor further comprises electrically-isolated structures made of conductive material comprising a conductive mesh.

7. A device comprising: a substantially flexible substrate; a touch sensor disposed on the substantially flexible substrate, the touch sensor comprising a plurality of capacitive nodes formed from drive or sense electrodes made of flexible conductive material configured to bend with the substantially flexible substrate, wherein: the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection to form a mesh grid; the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display; and one or more computer-

readable non-transitory storage media embodying logic that is configured when executed to control the touch sensor.

8. The device of claim 7, wherein the touch sensor further comprises tracking disposed on the substantially flexible substrate configured to provide drive or sense connections to or from the drive or sense electrodes and configured to bend with the substantially flexible substrate.

9. The device of claim 7, wherein the first and second conductive lines are made from one of carbon nanotubes, copper, silver, a copper-based material, or a silver-based material.

10. The device of claim 7, wherein the touch sensor comprises: a single-layer configuration with drive and sense electrodes disposed only on a first surface of the substantially flexible substrate; or a two-layer configuration with drive electrodes disposed on the first surface of the substantially flexible substrate and sense electrodes disposed on a second surface of the substrate opposite the first surface.

11. The device of claim 7, wherein the touch sensor is a mutual-capacitance touch sensor or a self-capacitance touch sensor.

12. The device of claim 7, wherein the touch sensor further comprises electrically-isolated structures made of conductive material comprising a conductive mesh.

13. The apparatus of claim 1, wherein the first and second conductive lines are substantially orthogonal to one another.

14. The apparatus of claim 1, wherein the first and second conductive lines are non-linear.

15. The apparatus of claim 1, wherein the first and second conductive lines are made of fine lines of metal having a thickness of approximately 5 micrometers or less and a width of approximately 10 micrometers or less.

16. The device of claim 7, wherein the first and second conductive lines are substantially orthogonal to one another.

17. The device of claim 7, wherein the first and second conductive lines are non-linear.

18. The device of claim 7, wherein the first and second conductive lines are made of fine lines of metal having a thickness of approximately 5 micrometers or less and a width of approximately 10 micrometers or less.

19. The apparatus of claim 1, wherein the first and second conductive lines of the flexible conductive material of the drive or sense electrodes is wider at the one or more edges of the display.

20. The device of claim 7, wherein the first and second conductive lines of the flexible conductive material of the drive or sense electrodes is wider at the one or more edges of the display.

5.4. Level of Ordinary Skill in the Art

77. It is my understanding that factors defining the level of ordinary skill in the art include: (1) the types of problems encountered in the art; (2) the prior art solutions to those problems; (3) the rapidity with which innovations are made; (4) the sophistication of technology; and (5) the educational level of active workers in the field.

78. Using these factors, a person of ordinary skill in the art ("POSITA") at the time of the alleged invention of the '311 patent (which, as discussed above, is October 28, 2011 (Ex. 1001 at cover)) would have had a relevant 4-year technical degree in Electrical Engineering, Computer Engineering, Computer Science, Materials Science, or the like, and 2–3 years of experience in touch sensor design. One can also obtain similar knowledge and experience through other means.

5.5. Claim Construction

79. As discussed above, is my understanding that in this proceeding, the claim terms should be given their plain and ordinary meaning as understood by one of ordinary skill in the art (a "POSITA"), consistent with the disclosure and the prosecution history.

80. After reviewing the disclosure and the prosecution history, I do not believe that any constructions other than the plain and ordinary meaning of the claim terms of the '311 patent are necessary. However, I believe that for one of the specific

claim terms of the '311 patent—"mesh grid"—some additional explanation of the plain and ordinary meaning of those terms to a POSITA may be helpful. I have addressed other claim interpretation issues below when discussing specific claims and the applicability of the prior art to those claims.

"to form a mesh grid"

81. Each independent claim of the '311 patent ("apparatus" claim 1 and "device" claim 7) requires that "the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection to form a mesh grid." A POSITA would understand this claim term to require that at least one electrode (that is, either the drive or sense electrode) itself be a mesh grid, *not* that a first conductive line from a first electrode electrically contact a second conductive line from a second electrode (which would cause an electrical short between the electrodes and prevent the electrodes from working as a capacitive touch sensor).

82. This interpretation is consistent with the '311 patent specification's use of the term "mesh" when describing a single electrode in its capacitive touch sensors, where each electrode is made up of intersecting "fine lines of conductive material," Ex. 1001 at 2:15–20; 5:56–6:30. An example of this type of "mesh" electrode is displayed, for example, in Figure 2A of the '311 patent:

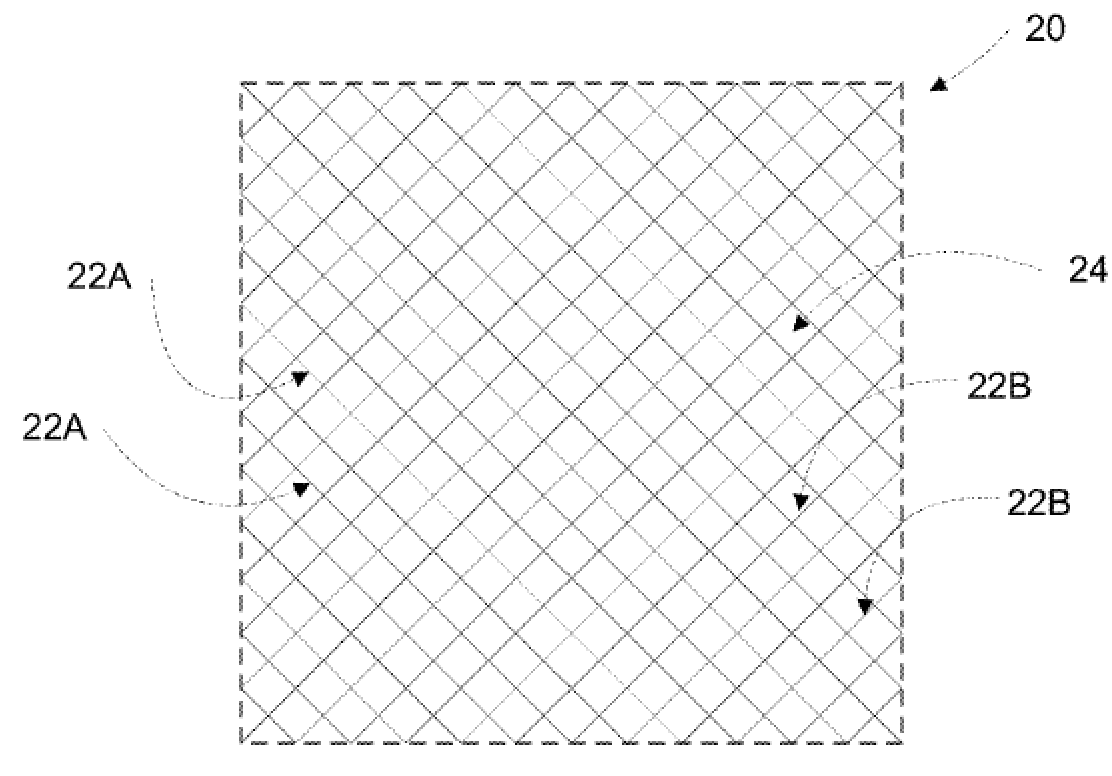


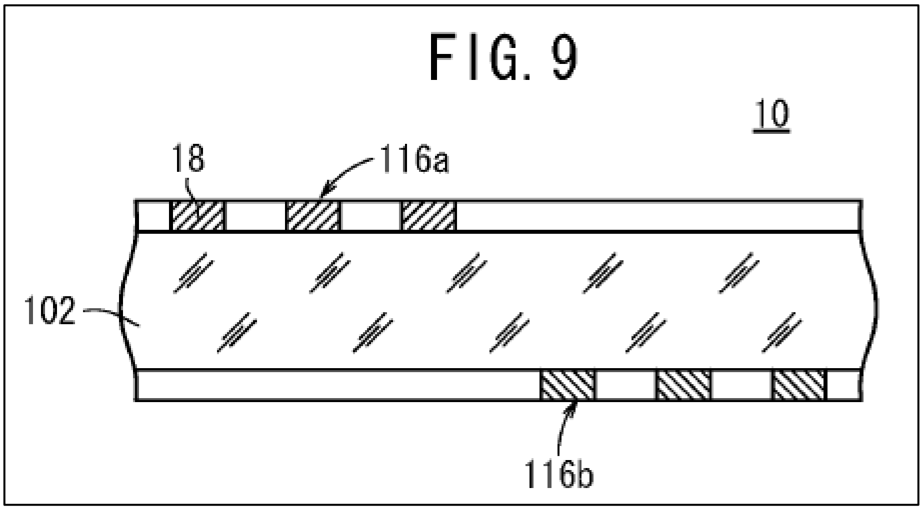
Figure 2A

6. OVERVIEW OF THE PRIOR ART

6.1. Kuriki (Ex. 1003)

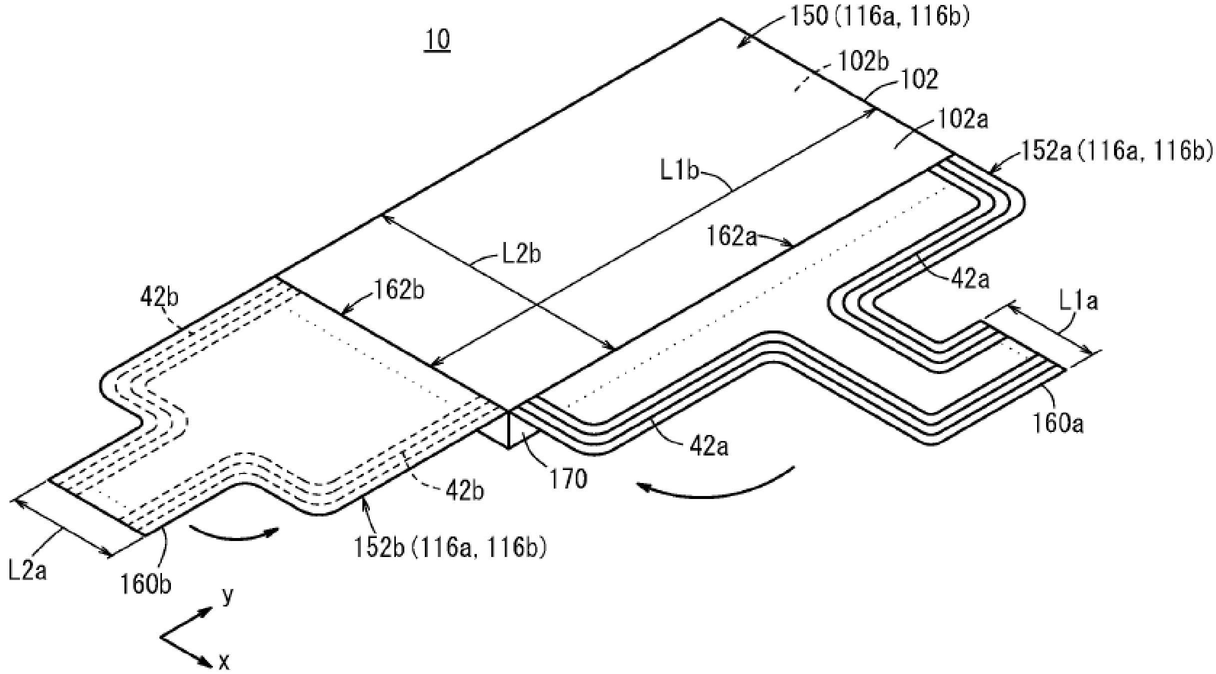
83. The Kuriki patent describes a "conductive sheet . . . for use in a projected capacitive touch panel," and methods for "forming an electrode for a touch panel" in that conductive sheet. Ex. 1003 at 1:17-20; 2:37-50. These "electrodes for a touch panel" are composed of what Kuriki refers to a "large lattice" pattern made up of a number of square "small lattices 18"; in other words, what a POSITA would recognize as a mesh electrode. Ex. 1003 at 12:9-25.

84. In Figure 9, Kuriki displays a cross-section of the structure of an example "conductive sheet 10," containing silver "conductive layers" 116a/116b of "small lattices" 18, which are layered on either side of a polyethylene terephthalate (PET) "transparent support 102," as described at 11:64-12:25 of Kuriki:



85. In Figure 8, Kuriki further illustrates the structure of the conductive sheet 10, noting that the sheet includes "a sensing region 150" as well as "terminal wiring region[s]" 152a and 152b. Ex. 1003 at 11:64-12:8. Kuriki later describes how these terminal wiring regions have "terminal wiring patterns" that connect the conductive patterns of the sensing region "to an IC circuit for position calculation or the like." Ex. 1003 at 18:35-53:

FIG. 8



86. In different views of this "conductive sheet 10," Kuriki's Figs. 10 and 12 show the top and bottom surfaces of the PET "transparent support 102." Ex. 1003 at 12:9-13:9. Kuriki explains that the "small lattices 18" have a "smallest square shape" and are connected together to form "conductive large lattice" (i.e., mesh) electrodes 16A and 16B on the top and bottom surfaces of that PET transparent support (i.e., the substrate), Ex. 1003 at 12:9-13:9. Kuriki states that if the "side length of each small lattice" (that is, the side length of each individual square in the mesh) falls into a range of "50 to 500 μm, more preferably 150 to 300 μm . . . , the conductive sheet has high transparency and thereby can be suitably used at the front of a display device with excellent visibility." Ex. 1003 at 12:34-39. These "large

lattice" electrodes 16A and 16B, when connected together, form checkerboard-like "conductive patterns" 26A and 26B in the "sensing region 150" of Kuriki's device, Ex. 1003 at 12:40-46; 12:64-13:3, as shown in Figs. 10 (top) and 12 (bottom) of Kuriki:

FIG. 10

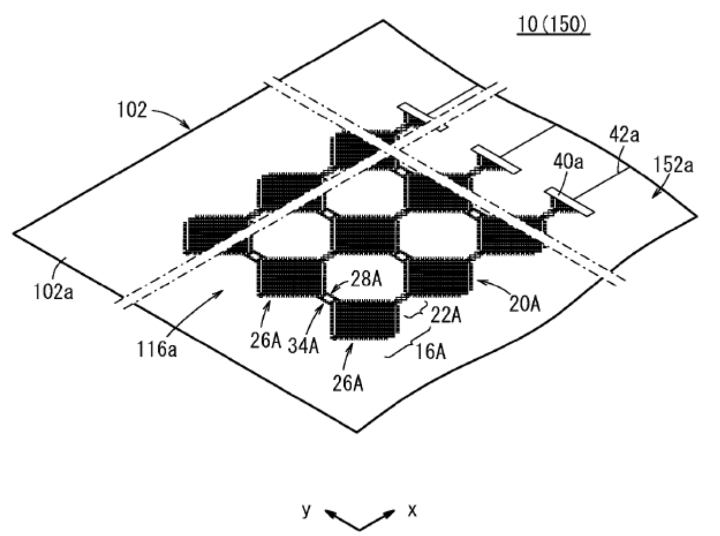
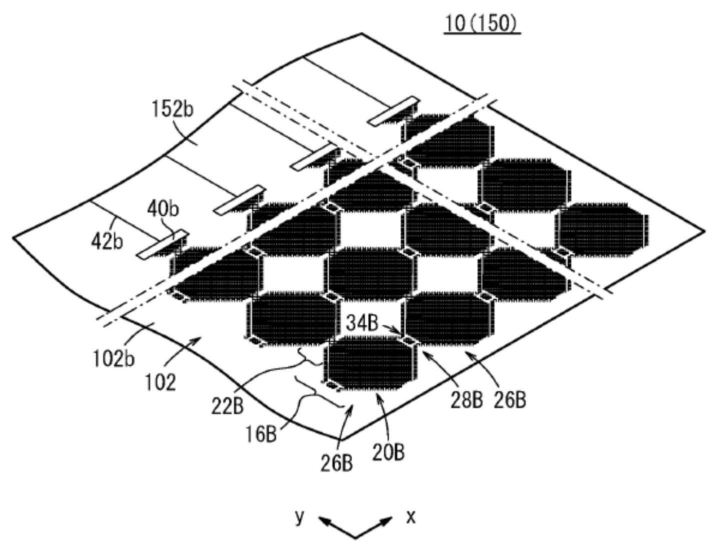


FIG. 12



87. The "large lattice" electrodes 16A and 16B are in turn electrically connected together by "connections" 22A and 22B, "connections" which are themselves made up of "medium lattices" 24, which in turn (like the "large lattices" 16A and 16B) are formed from a combination of "small lattices" 18. Ex. 1003 at 12:9-25. The sensing region 150 is "connected to an IC circuit for position calculation" by "terminal wiring patterns" 42a/42b, Ex. 1003 at 18:35-45. Kuriki explains that "when a finger comes into contact" with its capacitive touch screen, "signals are transmitted from the first conductive pattern 26A and the second conductive pattern 26B corresponding to the finger touch position to the IC circuit. The finger touch position is calculated in the IC circuit based on the transmitted signals." Ex. 1003 at 18:46-53.

88. I note that a separate international patent application also filed by the named inventor of Kuriki, describing the same "lattice" electrodes as those found in Kuriki, notes that the "lattice" electrodes of Kuriki may be used in both "self or mutual capacitance" implementations. Ex. 1017 at 16:30-25:18 (discussing the "lattice" electrodes found in Kuriki); 25:19-25 (disclosing that Kuriki's "lattice" electrodes can be used in either "self or mutual capacitance" scenarios). A POSITA would have understood as much from only the structural descriptions in Kuriki as well.

89. Regarding the materials used in Kuriki's capacitive touch sensors, Kuriki discloses that its "transparent support 102 may be a plastic film[or] a plastic plate . . . such as polyethylene terephthalates (PET)," and that "PET is particularly preferred from the viewpoints of light transmittance, workability, etc." Ex. 1003, 23:3-23. To manufacture the "large lattice" electrodes, Kuriki explains that metallic silver is formed on the PET "transparent support" to create the conductive metal patterns of the "small lattices" that make up the "large lattice" electrodes. Ex. 1003 at 27:48-28:38; 29:55-30:33. Kuriki describes this portion of the capacitive touch sensor as its "conductive metal portion." Ex. 1003 at 28:40-51.

90. Fig. 11 and Fig. 13 of Kuriki provide additional detail as to the patterns of the conductive silver "large lattices" 16A/16B:

FIG. 11

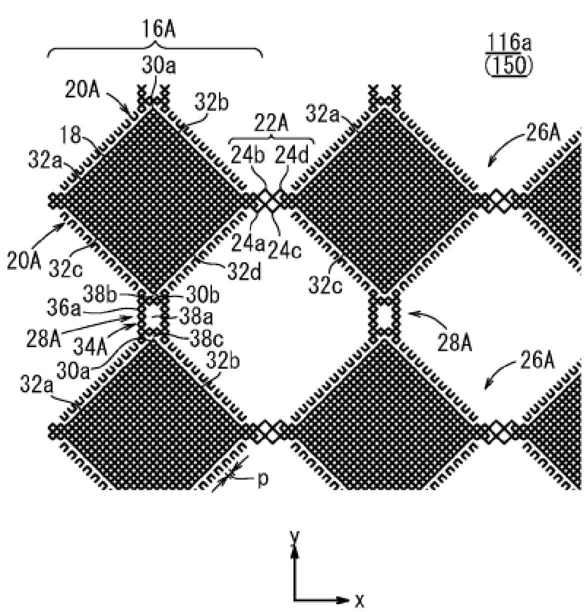
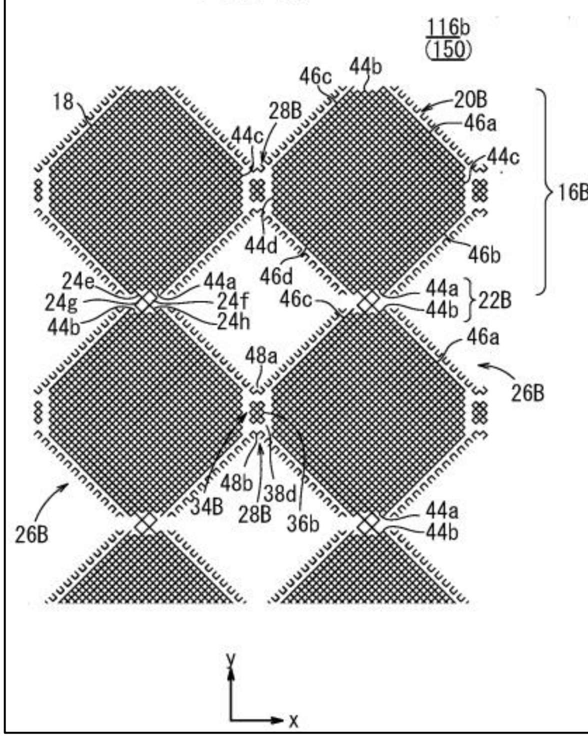
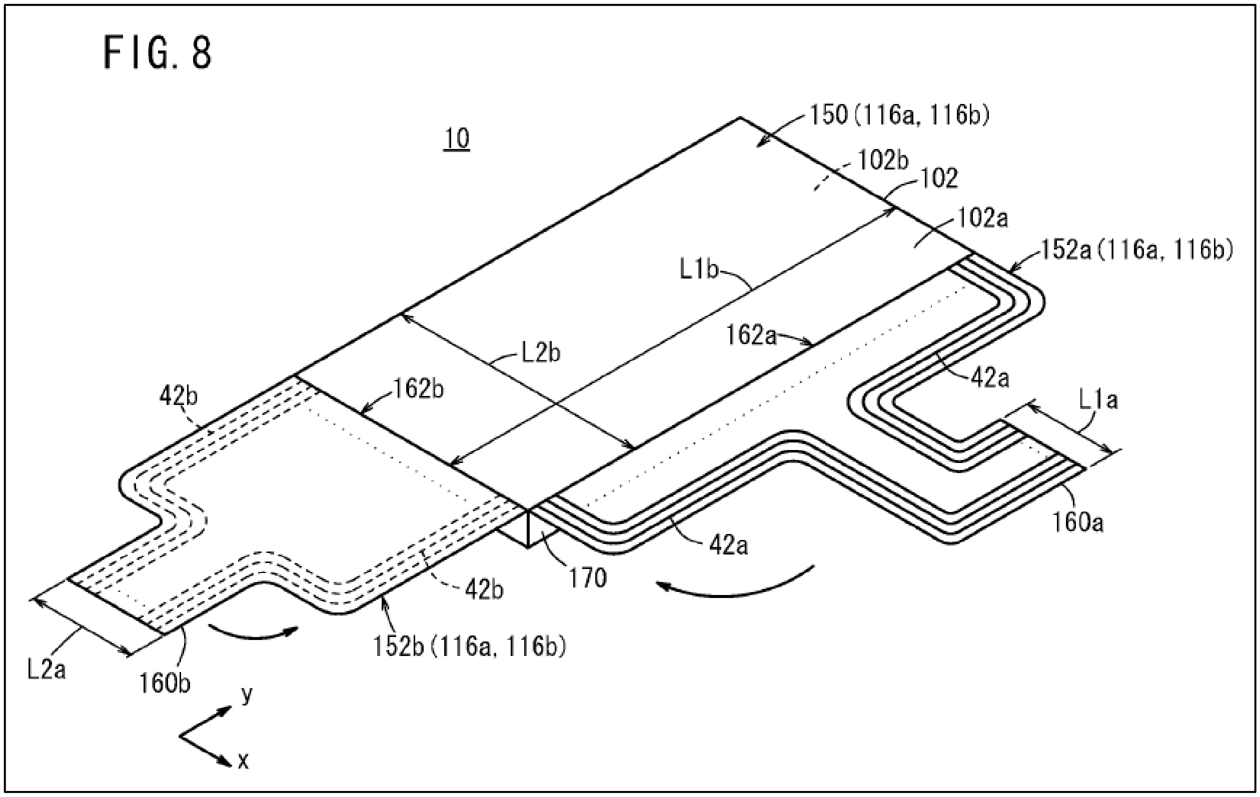


FIG. 13



91. As discussed above, Kuriki describes these electrode patterns as "lattices," each of which is made up of conductive silver lines that have a width of between 5 and 9 micrometers. Ex. 1003 at 29:10-41. The fine width of these silver lines allows for "markedly improved" "visible light transmittance"/"visibility" through these "large lattice" electrodes, with a visible light transmittance of "most preferably 95% or more." Ex. 1003 at 29:10-41. Kuriki states that when the "side length of each small lattice" (the length of each square in the mesh) falls between "50 to 500 μm, more preferably 150 to 300 μm . . . the conductive sheet has high transparency and thereby can be suitably be used at the front of a display device with excellent visibility." Ex. 1003, 12:34-39

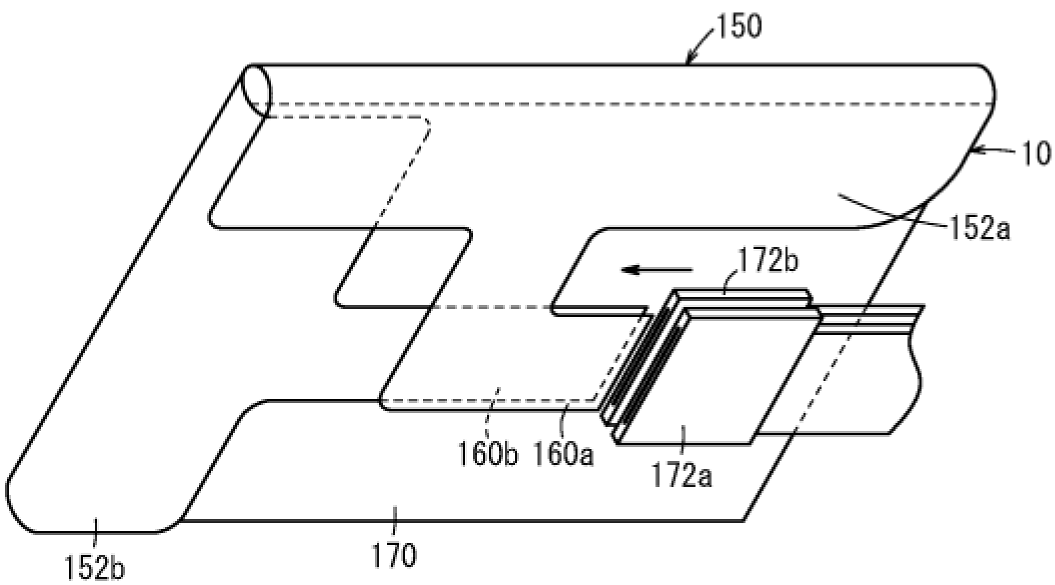
92. In addition to the "conductive metal portions" described above, Kuriki additionally teaches "electrically isolated" portions of metal lattice 28A/28B that are "disposed between the adjacent . . . conductive patterns" 26A/26B formed from "large lattices" 16A/16B. Ex. 1003 at 12:40-46; 12:64-13:3. After forming the silver "lattice" electrodes layered onto a PET "transparent support," Kuriki teaches that the conductive sheet 10 is then "placed on a liquid crystal display panel 170." Ex. 1003 at 21:3-7. This is illustrated in Fig. 8 of Kuriki:



93. Fig. 8 shows the two "terminal wiring region[s]" 152/152b of the conductive sheet 10, which contain "conductive patterns" and "terminal wiring patterns" 42a/42b used to connect the "lattice" electrodes to the controller of Kuriki's touchscreen device. Ex. 1003 at 11:64-12:8; 20:18-21:2. Kuriki discloses that these "terminal wiring regions" are "bent toward the back side of the sensing region 150 (i.e. the back side of the liquid crystal display panel 170)"—in other words, wrapped around the edges of that LCD panel. Ex. 1003 at 21:8-12. After the terminal wiring regions have been wrapped around the edges of the LCD panel, Kuriki explains that the terminal wiring regions can be "electrically connected to an IC circuit for position calculation, etc." via "connectors 172a, 172b," after which

"the production of one touch panel is completed." Ex. 1003, 21:13-17. The resulting touchscreen is illustrated by Fig. 18:

FIG. 18



6.2. Mikladal (Ex. 1004)

94. The Mikladal patent describes a "capacitive touch sensitive film" that "can be used as a touch sensitive element in a touch sensing device." Ex. 1004 at 3:37-4:11. Specifically, Mikladal discloses that this "touch sensitive film is formed as a flexible structure so as to allow bending thereof along a three dimensional surface." Ex. 1004 at 7:19–26. Mikladal describes the "novel possibilities" that this flexible "touch sensitive film" creates (Ex. 1004 at 7:31-44):

> Flexibility and/or deformability of the touch sensitive film in combination with the unique sensitivity performance

> thereof opens entirely novel possibilities to implement touch sensing devices. For example, a touch sensitive film serving as the user interface of a mobile device can be bent or formed to extend to the device edges so that the touch sensitive film can cover even the entire surface of the device. In a touch sensitive film covering different surfaces of a three-dimensional device, there can be several touch sensing regions for different purposes. One sensing region can cover the area of a display to form a touch screen. Other sensing regions e.g. at the sides of the device can be configured to serve as touch sensitive element replacing the conventional mechanical buttons, e.g. the power button.

95. This type of flexible touch sensor is shown in Fig. 3 of the Mikladal patent, which Mikladal describes as "a mobile electronic device **6** having a touch screen **7** comprising a touch sensitive film **1** according to Fig. 1 bent or deformed along the curved side surface of the device having a radius of curvature r=4mm" (Ex. 1004 at 14:1-5):

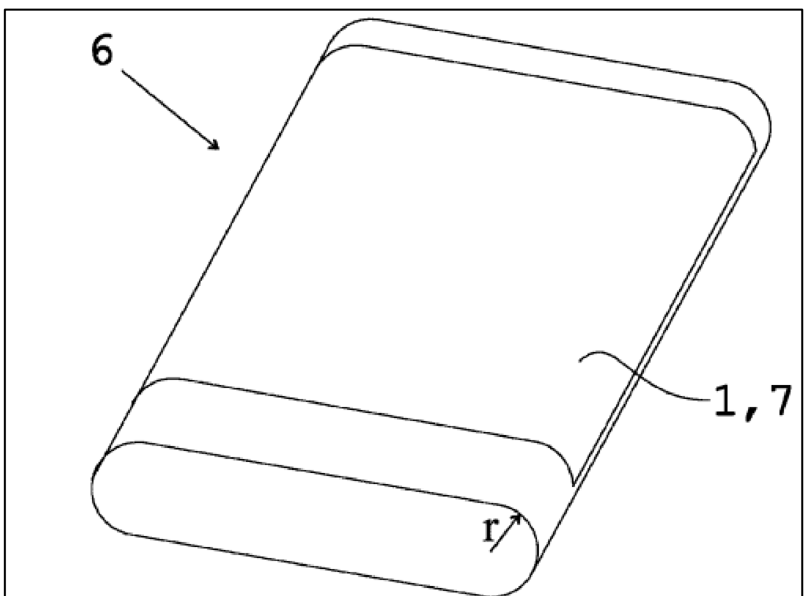


Fig. 3

96. Mikladal explains that this flexible capacitive touch sensor is composed of a "conductive layer 3," which can be composed of (among several options) "metal nanowires" (Ex. 1004 at 6:43-63, 12:10-11) on a "substrate 2" which "can be made of, for example, polyethylene terephthalate PET" (Ex. 1004 at 12:10-25). This flexible capacitive touch sensor can then be layered "on a display as part of a touch screen." Ex. 1004 at 12:26-35.

6.3. Philipp (Ex. 1005)

97. The Philipp patent application discloses capacitive touch sensors for a touchscreen display that are composed of mesh electrodes. Ex. 1005 at Abstract, ¶¶ [0006], [0018], [0041]-[0042]. In particular, Philipp discloses mesh electrodes that are made up of non-linear conductive lines—or, as Philipp describes them "wavy lines . . . formed of a series of curves," which Philipp explains "avoid creating moiré patterns when overlaying a display." Ex. 1005 at ¶¶ [0041]-[0045]. A mesh electrode with these wavy lines can be seen, for example, in Fig. 4 of Philipp:

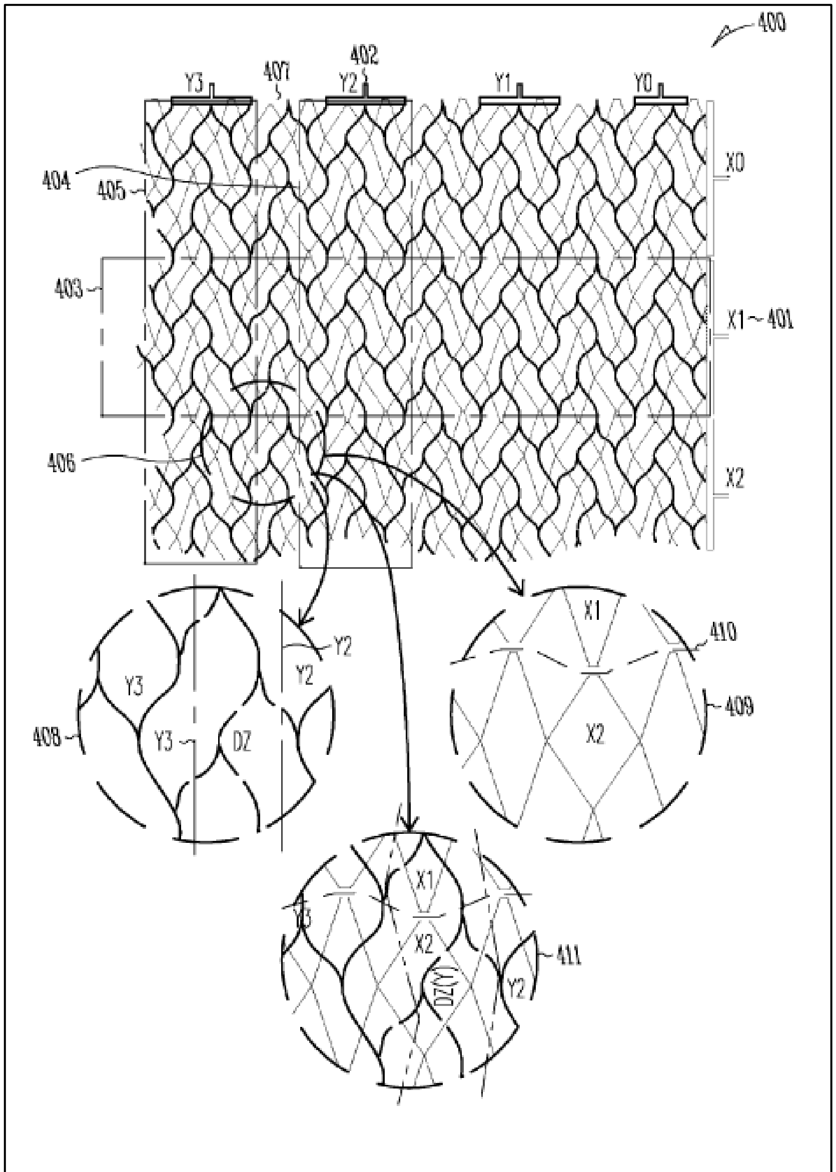


Fig. 4

6.4. Rappoport (Ex. 1006)

98. Rappoport describes devices with touchscreen displays including "capacitive touch sensor electrodes." Ex. 1006 at ¶¶ [0029]; [0049]. At the edges of the device, Rappoport discloses that "conductive traces," "such as control lines 62" which have been "formed on the surface of substrate 60" should be "enlarged

(e.g. widened and/or thickened)" in the vicinity of bend axis 56" (i.e., the edge of the device around which those conductive traces/control lines are bent). Ex. 1006 at ¶¶ [0038]-[0043]. These thickened conductive lines are illustrated by Figs. 7-9 of Rappoport:

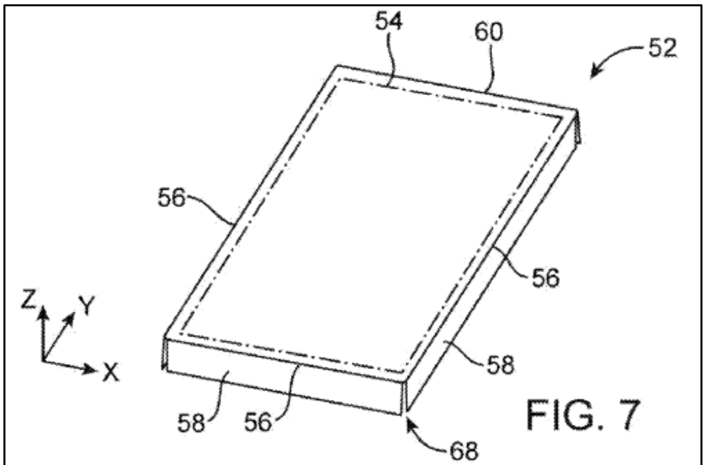


FIG. 7

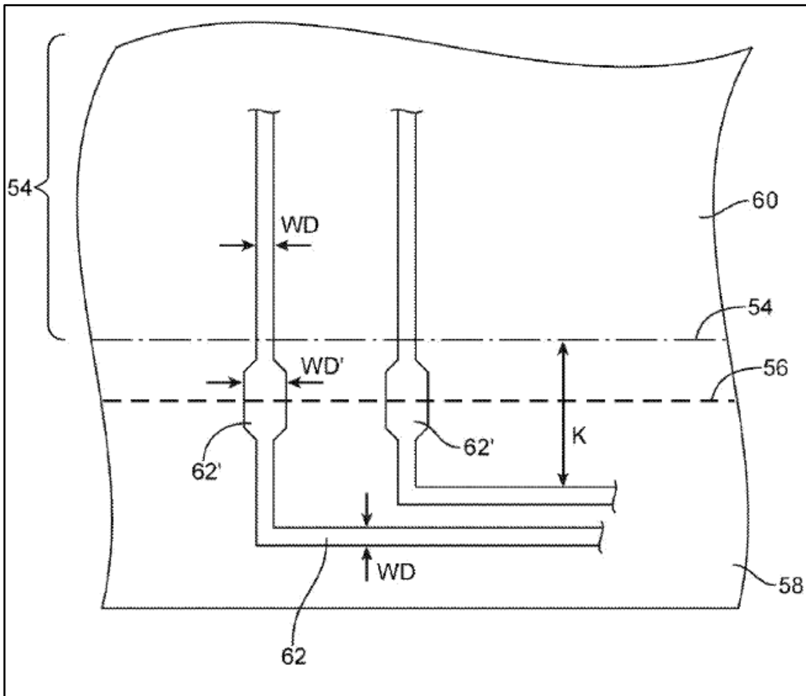


FIG. 8

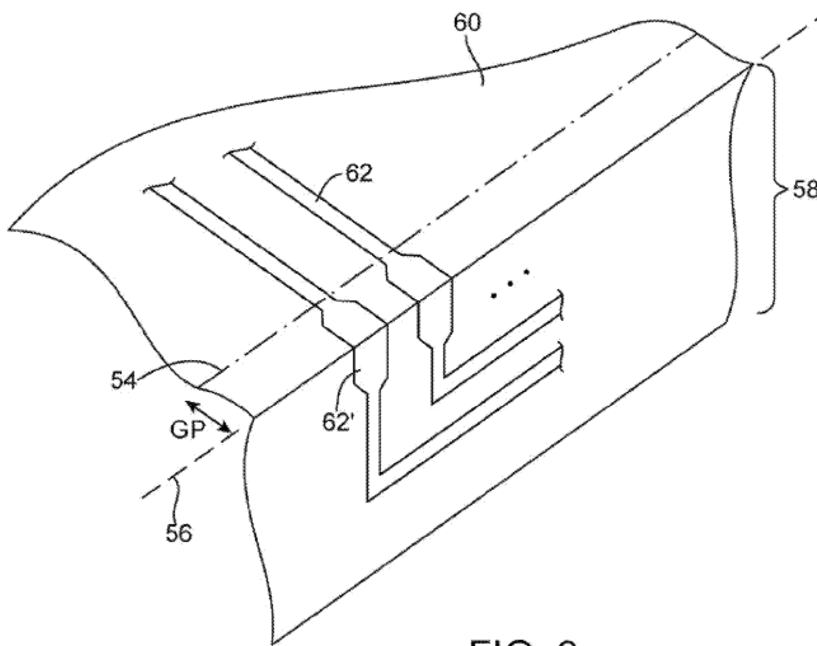


FIG. 9

99. These widened/thickened lines at the edges of the device are desirable, Rappoport explains, because they "help ensure that traces 62 are not cracked or otherwise damaged" at the axis of bending. Ex. 1006 at ¶ [0043].

6.5. Moran (Ex. 1007)

100. The Moran publication shares the same assignee (3M) and a named inventor (Matthew H. Frey) (Ex. 1007 at cover) with the Frey I prior art reference that the Examiner of the '311 patent cited during prosecution to disclose the claim limitation "flexible conductive material of the drive or sense electrodes [that] comprises first and second conductive lines that electrically contract one another at an intersection to form a mesh grid," Ex. 1002 at 68-85 (March 19, 2015 Non-Final Rejection). Like Frey I, Moran discloses the mesh electrodes cited by the Examiner

of the ’311 patent, along with many of Frey I’s other substantive disclosures. However, Moran (unlike Frey I) additionally discloses that both its drive *and* sense electrodes (“electrically conductive micropatterns” in Moran’s terminology) are layered onto the same surface of a substantially flexible substrate. Ex. 1007 at 8:29-9:5 (both first and second micropatterns are “patterned onto the surface of the substrate in a mesh geometry,” as long as “the second conductive micropattern” can be “electrically isolated from the first conductive micropattern”).

101. Moran discloses “capacitive touch screen sensors that are integrated with electronic displays.” Ex. 1007 at 7:4-9, 6:7-26. These “touch screen sensors” are composed of “micropatterned substrates that comprise a visible light transparent substrate and at least two electrically conductive micropatterns disposed on or in the visible light transparent substrate.” Ex. 1007 at 4:18-26. Moran’s touch screen sensors are then “overla[id]” on “a viewable portion of the information display.” Ex. 1007 at 6:30-7:3. Once overlaid onto the display, the sensors can be connected to controller circuitry for “driving the conductive micropatterns with electrical signals for the purpose of capacitively detecting the presence or location of a touch event to an information display.” Ex. 1007 at 6:7-26. For the structure of these “micropatterns,” Moran explains that “[p]referred conductive micropatterns include regions with two dimensional meshes (or simply, meshes), where a plurality of linear micropattern features (often referred to as conductor traces or metal traces) such as

micropatterned lines define enclosed open areas within the mesh." Ex. 1007 at 9:17-22. An example of a two-dimensional mesh is shown in Fig. 2 of Moran:

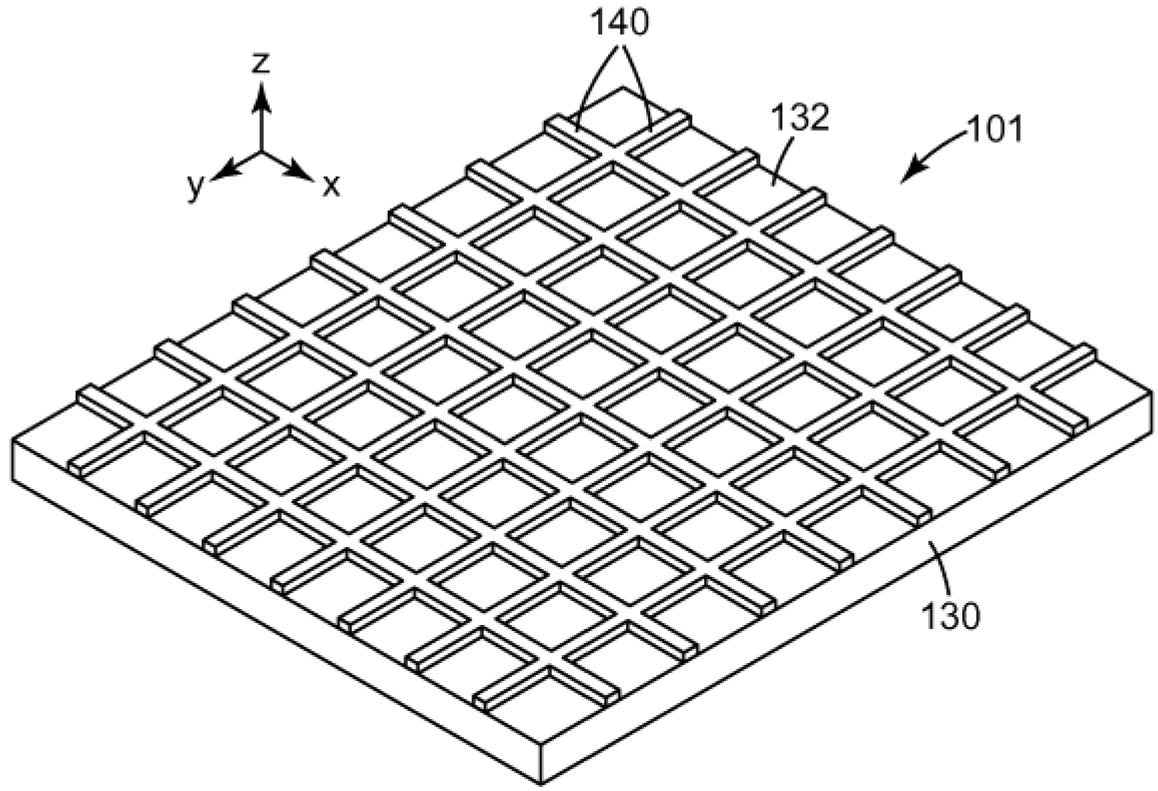


Fig. 2

102. To manufacture the "visible light transparent substrate 130" shown above, Moran explains that "useful polymers" "include polyethylene terephthalate (PET)." Ex. 1007 at 7:16-26. The "electrically conductive micropattern 140" layered onto the substrate "can be formed of a plurality of linear metallic features." Ex. 1007 at 7:25-26. Useful metals for this micropattern, Moran explains, are silver and/or copper. Ex. 1007 at 22:13-15. This PET substrate and conductive metal

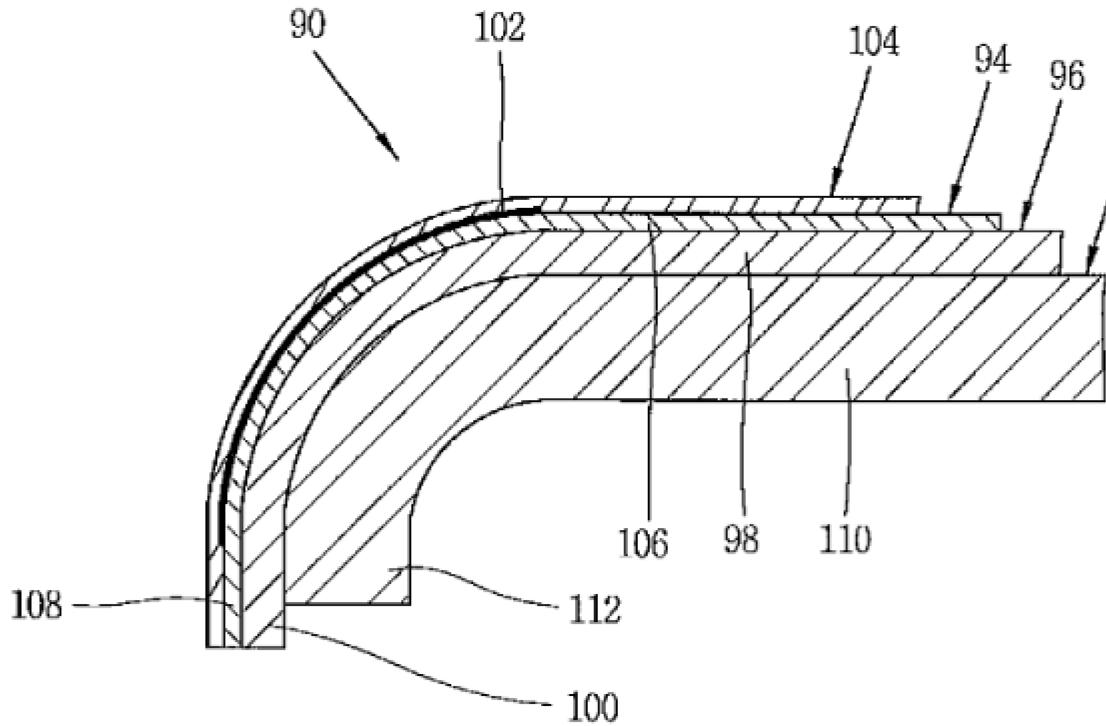
micropattern upon it are "substantially planar and flexible." Ex. 1007 at 5:17-19; 8:15-16.

103. Because the micropattern's conductive metal lines take up only a relatively small percentage of its area (Moran explains that between 0.05% and 5% is preferable), Moran's touch sensor is "visible light transparent," so that "information (e.g., text, images, or figures) that is rendered by the display can be viewed through the touch sensor." Ex. 1007 at 8:13-21; 11:19-12:6. Moran further explains that, in order to create "uniformity of light transmittance across the sensor, electrically "isolated squares of conductor" are also layered on the PET substrate in between the conductive micropatterns of the touch sensor. Ex. 1007 at 20:15-31.

6.6. Joo (Ex. 1008)

104. Joo describes a transparent "touch sensitive" or "touch input portion" for the touchscreen of a mobile device. Ex. 1008 at ¶ [0038]. Figure 7 of Joo depicts an example of "touch sensing portion or touch input portion 64" (Ex. 1008 at ¶ [0053]):

FIG. 7



105. More specifically, Joo explains that this "touch input portion 94" is layered onto a surface of "support member 96," where both the touch input portion 94 and support member 96 in turn are layered onto "display unit 92." Ex. 1008 at ¶¶ [0060]-[0063]. The support member 96, Joo discloses, is "formed of a transparent material, such as a polycarbonate material." Ex. 1008 at ¶¶ [0042], [0053], [0061].

106. Joo explains that the "display unit 92 is bent at the edge of the upper display portion 110 in the form of a curved surface, thereby forming a side display

portion 112." Ex. 1008 at ¶ [0063]. Joo further discloses that because "the touch input portion for generating input when being touched is extendingly formed at the side surface portion of the cover as well as the upper surface portion thereof. Accordingly, a separate side key is not required to be mounted at the side surface of the terminal for generating input, thereby simplifying the manufacturing process thus to reduce the manufacturing cost and make the enhanced appearance of the terminal." Ex. 1008 at ¶ [0067].

7. THE COMBINATION OF KURIKI AND MIKLADAL

107. Kuriki and Mikladal each come from the same field of endeavor—the design of capacitive touch sensors for use in touchscreen devices. And both Kuriki and Mikladal address the same problem: the design of transparent capacitive sensors that can be layered over a device's display screen and used to create a touchscreen capable of controlling that device. In this particular case, a POSITA would have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

108. The particular combinations of Kuriki and Mikladal's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis indicates that a POSITA would have been motivated to combine the features in Kuriki and

Mikladal to arrive at what is claimed in the ’311 patent based on the disclosures in the prior art and that POSITA’s knowledge of the art.

7.1. Claims 1 and 7

1[preamble]/7[preamble]: “An [apparatus/device] comprising:”

109. Kuriki discloses a capacitive touchscreen apparatus or device—specifically, a “conductive sheet 10 [that] is placed on a liquid crystal display panel 170” and around that LCD panel in order to be “electrically connected to an IC circuit for position calculation, etc.,” resulting in a “touch panel,”[3] Ex. 1003 at 21:3-17. Kuriki goes on to note that in this apparatus/device, “finger touch position is calculated in the IC circuit based on the transmitted signals” from the conductive sheet 10. Ex. 1003, 18:46-53.

110. Accordingly, a POSITA would have appreciated that Kuriki discloses this claim limitation.

1[a]/7[a]: “a substantially flexible substrate”

111. As noted above, the only example given of a “suitable material” for the “flexible substrate” described in the ’311 patent is “polyethylene terephthalate (PET).” Ex. 1001 at 2:39-41; 3:1-4. Kuriki discloses a flexible substrate composed of this same material, stating that the “particularly preferred” material for

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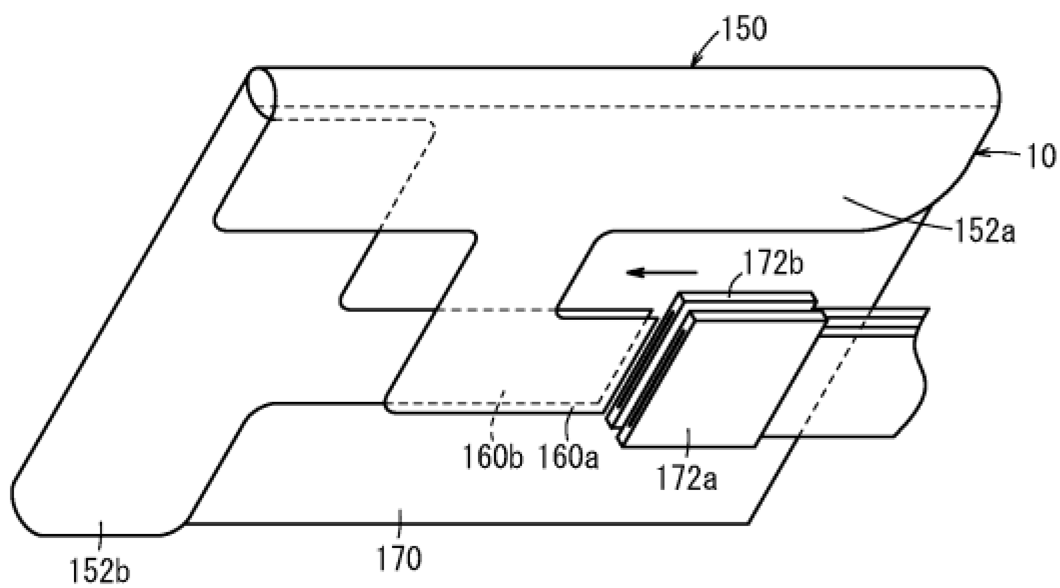
[3] These elements are illustrated in, for example, Fig. 17A of Kuriki.

"transparent support 102"[4] (the claimed substrate) is "polyethylene terephthalates (PET)" because of its "light transmittance" and "workability." Ex. 1003 at 23:3-23.

112. Furthermore, Kuriki explains that the PET conductive sheet 10 is flexible enough to be "bent toward the back side of the sensing region 150 (i.e. the back side of the liquid crystal display panel 170)" to be wrapped around the edges of liquid crystal display panel 170. Ex. 1003 at 21:8-12. This is shown by Fig. 18 of Kuriki:

FIG. 18



[4] Substrate 102 is illustrated in, for example, Fig. 8 of Kuriki.

113. Accordingly, a POSITA would have appreciated that Kuriki discloses this claim limitation.

1[b]/7[b]: "a touch sensor disposed on the substantially flexible substrate"

114. Kuriki's "conductive sheet 10," which is "used in the touch panel," contains a "sensing region 150" made of "conductive lattices" "formed on" the "main surface[s]" 102a/102b of "transparent support 102." Ex. 1003 at 11:57-12:25. These lattices are used to create "conductive patterns" (26A/26B), resembling a checkerboard, which are used to determine a "finger touch position." Ex. 1003 at 18:35-53. A POSITA would therefore have appreciated that Kuriki's sensing region composed of conductive lattices (which is formed on the surfaces of the PET transparent support) disclosed the claimed "touch sensor disposed on the substantially flexible support."

1[c]/7[c]: "the touch sensor comprising [drive or sense electrodes/a plurality of capacitive nodes formed from drive or sense electrodes] made of flexible conductive material configured to bend with the substantially flexible substrate"

115. This claim limitation contains two separate sub-limitations: (1) that the touch sensor comprises "drive or sense electrodes" or a "plurality of capacitive nodes formed from drive or sense electrodes"; and (2) that those electrodes are "made of flexible conductive material configured to bend with the substantially flexible

substrate." A POSITA would have recognized that both of these sub-limitations were disclosed by Kuriki, as I discuss below.

drive or sense electrodes / a plurality of capacitive nodes formed from drive or sense electrodes

116. A POSITA would have recognized that Kuriki disclosed drive or sense electrodes (claim 1) and a plurality of capacitive nodes formed from drive or sense electrodes (claim 8) through the "lattice" electrodes taught by Kuriki.

117. A POSITA would have readily understood that Kuriki's invention is directed to forming electrodes for a capacitive touch sensor. Kuriki states that "an electrode for a touch panel or the like can be easily formed" from "the same or different patterns . . . on each side (each of front and back sides) of one transparent support 102." Ex. 1003 at 11:51-56. Kuriki also explains throughout its disclosure that these electrodes (and its "conductive sheet 10") are meant for use in a capacitive touchscreen sensor, as opposed to the other types of touch sensors that I noted above, disclosing that its conductive sheet (and the electrodes on it) is "suitable for use in a projected capacitive touch panel." Ex. 1003 at 1:16-20. See also Ex. 1003 at 2:37-50; 5:47-52; 13:10-22, 14:65-15:20, 18:46-53, and Figures 11 and 13.

118. In fact, Kuriki provides a detailed disclosure of how its capacitive touch sensor works: noting that its capacitive touchscreen is capable of "sensing change in an electrostatic capacitance between a human finger and a conductive film to detect the position touched by the fingertip," and that "when a finger comes into contact"

with the touch sensor" then "signals are transmitted from the first conductive pattern 26A and the second conductive pattern 26B corresponding to the finger touch position to the IC circuit. The finger touch position is calculated in the IC circuit based on the transmitted signals." Ex. 1003 at 1:35-40; 18:46-53.

119. As noted above, Kuriki explains that the "sensing region 150" of its touchscreen sensor ("the conductive sheet 10") is made up of a number of conductive "large lattices 16" "formed on" the "main surface[s]" 102a/102b of a PET "transparent support 102." Ex. 1003 at 11:57-12:25. These "large lattices" make up the capacitive electrode "conductive patterns" discussed by Kuriki, and are illustrated by Fig. 10 and Fig. 12 of Kuriki:

FIG. 10

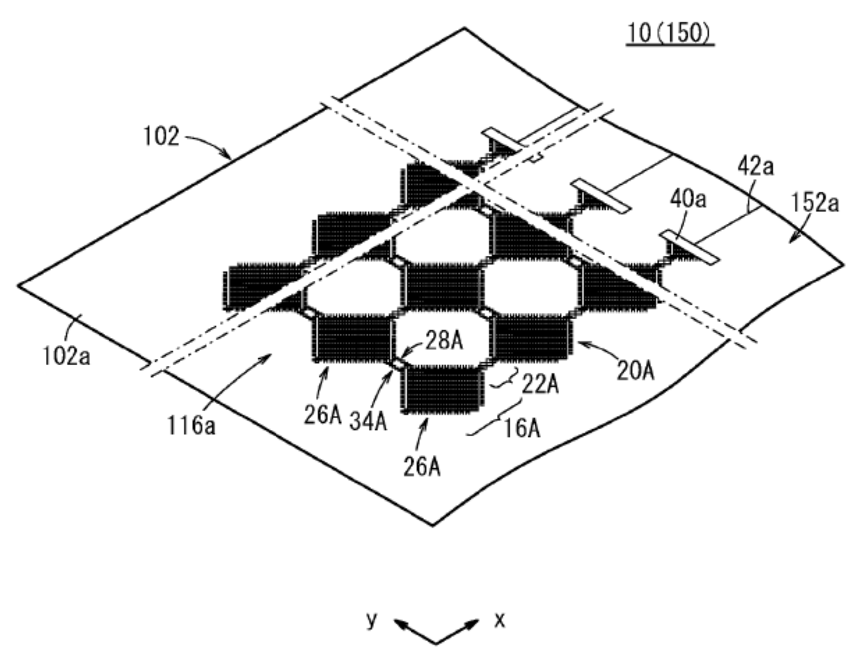
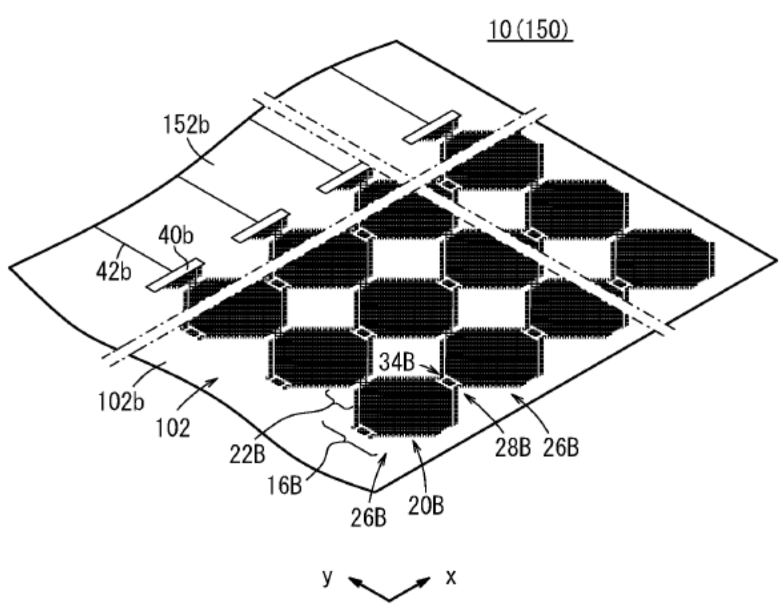


FIG. 12



120. A POSITA would have appreciated that Kuriki's conductive "lattice" electrodes formed on the surfaces of PET transparent support 102 disclose the claimed "drive or sense" electrodes of the '311 patent. As noted above, Kuriki explains that its capacitive electrodes work by "sensing change in an electrostatic capacitance between a human finger and a conductive film to detect the position touched by the fingertip," and that "when a finger comes into contact" with the touch sensor" then "signals are transmitted from the first conductive pattern 26A and the second conductive pattern 26B corresponding to the finger touch position to the IC circuit. The finger touch position is calculated in the IC circuit based on the transmitted signals." Ex. 1003 at 1:35-40; 18:46-53. Kuriki's description of the functionality of the lattice electrodes is identical to the '311 patent's description of

the functionality of the "capacitive nodes" created by its "drive and sense" electrodes: that "[w]hen an object touches or comes within proximity of the capacitive node, a change in capacitance may occur at the capacitive node and controller 12 may measure the change in capacitance." Ex. 1001 at 3:44-50.

121. Similarly, the '311 patent explains that its "touch sensor 10 may have drive electrodes disposed in a pattern on one side of a substrate and sense electrodes disposed in a pattern on another side of the substrate" (Ex. 1001 at 4:15-20), just as Kuriki discloses that "an electrode for a touch panel or the like can be easily formed" from "the same or different patterns . . . on each side (each of front and back sides) of one transparent support 102" (Ex. 1003 at 11:51-56). Kuriki also explains the functionality of these electrodes whereby signals from one electrode is coupled to the other electrode by a touch. (Ex. 1003 at 18:46-53). Mikladal similarly notes that "the electrodes used for supplying the signal and sensing the capacitive coupling are often called drive electrodes and sense electrodes, respectively." Ex. 1004 at 1:61-64.

made from flexible conductive material configured to bend with the substantially flexible substrate

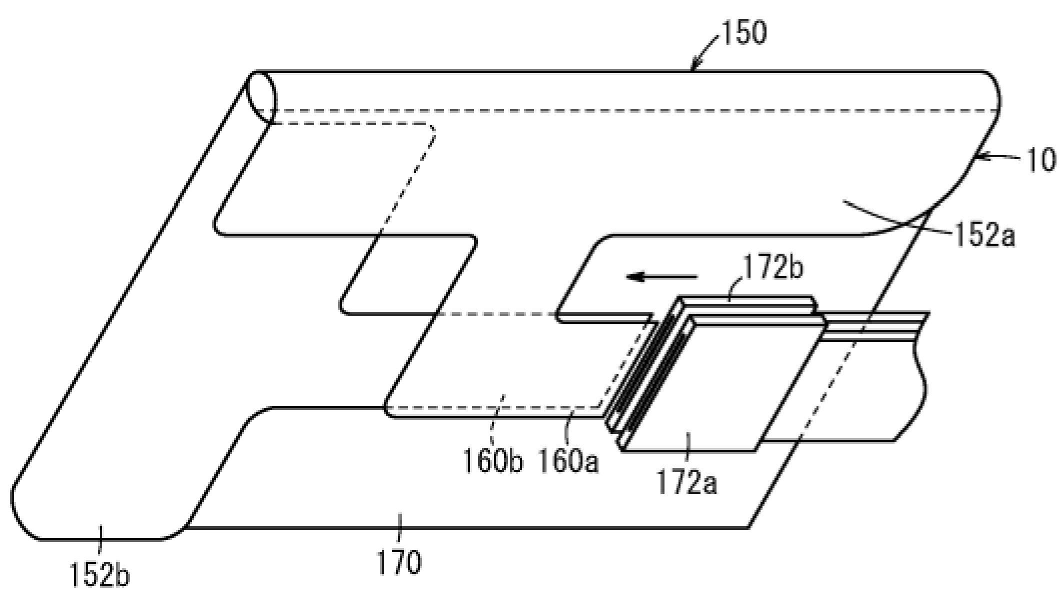
122. A POSITA would also have recognized that Kuriki's "lattice" electrodes were made from flexible conductive material configured to bend with Kuriki's flexible PET transparent support substrate, because Kuriki's electrodes are made from a known flexible conductive material: metallic silver. Ex. 1003 at 27:48-

28:38, 29:55-30:33. In fact, the silver used in Kuriki is the same material that the ’311 patent discloses for use in the “metal-mesh” electrodes of the flexible “touch-sensitive apparatus 612” of the “example mobile telephone” shown in Fig. 7. Ex. 1001 at 7:27-51 (“electrode pattern of touch-sensitive apparatus 612 made from metal-mesh technology with a copper, ***silver***, or other suitable metal mesh”).

123. Furthermore, a POSITA would have been well aware from other contemporary prior art references that silver, used as disclosed, is an inherently flexible conductive material that would bend along with a PET substrate. Moran, for example, explained that a silver micropattern formed on top of a PET substrate would together be “substantially planar and flexible.” Ex. 1007 at 5:17-19; 8:15-16. Similarly, U.S. Patent Application Publication No. US 2010/0123670, filed by the same assignee as that of the ’311 patent (Atmel Corporation) noted that metals such as copper or silver can be used to form “mesh” electrodes which are “malleable” and “can be readily flexed or kinked without damage.” Ex. 1012 at ¶¶ [0008]-[0009]. A 2010 paper by Hu et al. explained that “outstanding flexibility makes the Ag NW [silver nanowire] electrode attractive for flexible electronics,” such as “capacitive touch screens.” Ex. 1018 at 2955; 2962. And a U.S. patent application filed in March 2011 by Winoto et al. similarly noted the “favorable physical and mechanical properties” of “robust and flexible” silver nanowire matrices for use in “touch screens.” Ex. 1019 at ¶¶ [0025]; [0033]; [0081].

124. Perhaps most importantly, Kuriki itself teaches that the metallic silver that its electrodes are manufactured from is a flexible material configured to bend with the underlying flexible PET transparent support (the claimed substrate). Kuriki explains that the "terminal wiring patterns" 42a/42b are silver (Ex. 1003 at 27:48-28:38; 29:55–30:33) and are "bent toward the back side of the sensing region 150 (i.e. the back side of the liquid crystal display panel 170)" (along with the underlying transparent support 102) to be wrapped around the edges of LCD panel 170 (Ex. 1003 at 21:8-12), as illustrated in Fig. 18 of Kuriki:

FIG. 18



1[d]/7[d]: "the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection to form a mesh grid"

125. As I have discussed above, Kuriki's "large lattice" electrodes are made up of a number of square "small lattices," with these "small lattices" themselves formed from conductive silver lines that electrically contact each other at orthogonal intersections, all connected together to form the "large lattice" (in other words, forming a mesh grid). Ex. 1003 at 29:10-28. Kuriki provides detailed illustrations of these lattices in Figs. 11 and 13:

FIG. 11

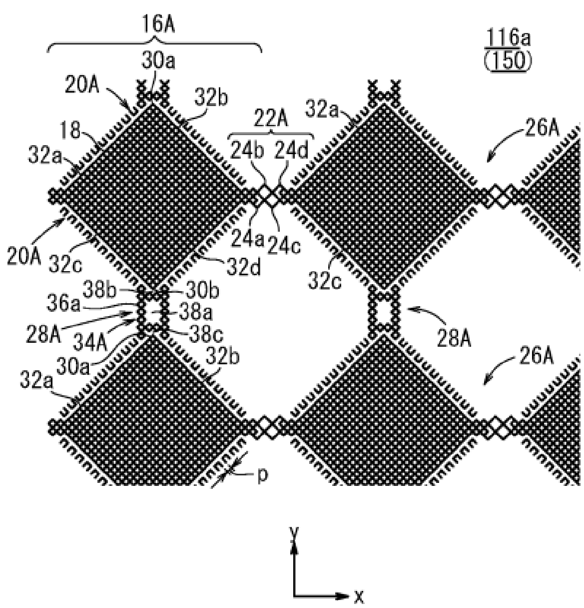
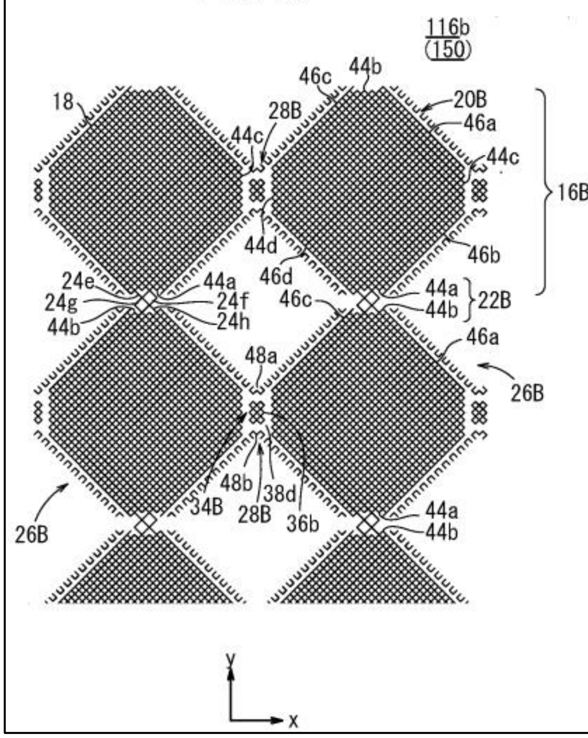


FIG. 13

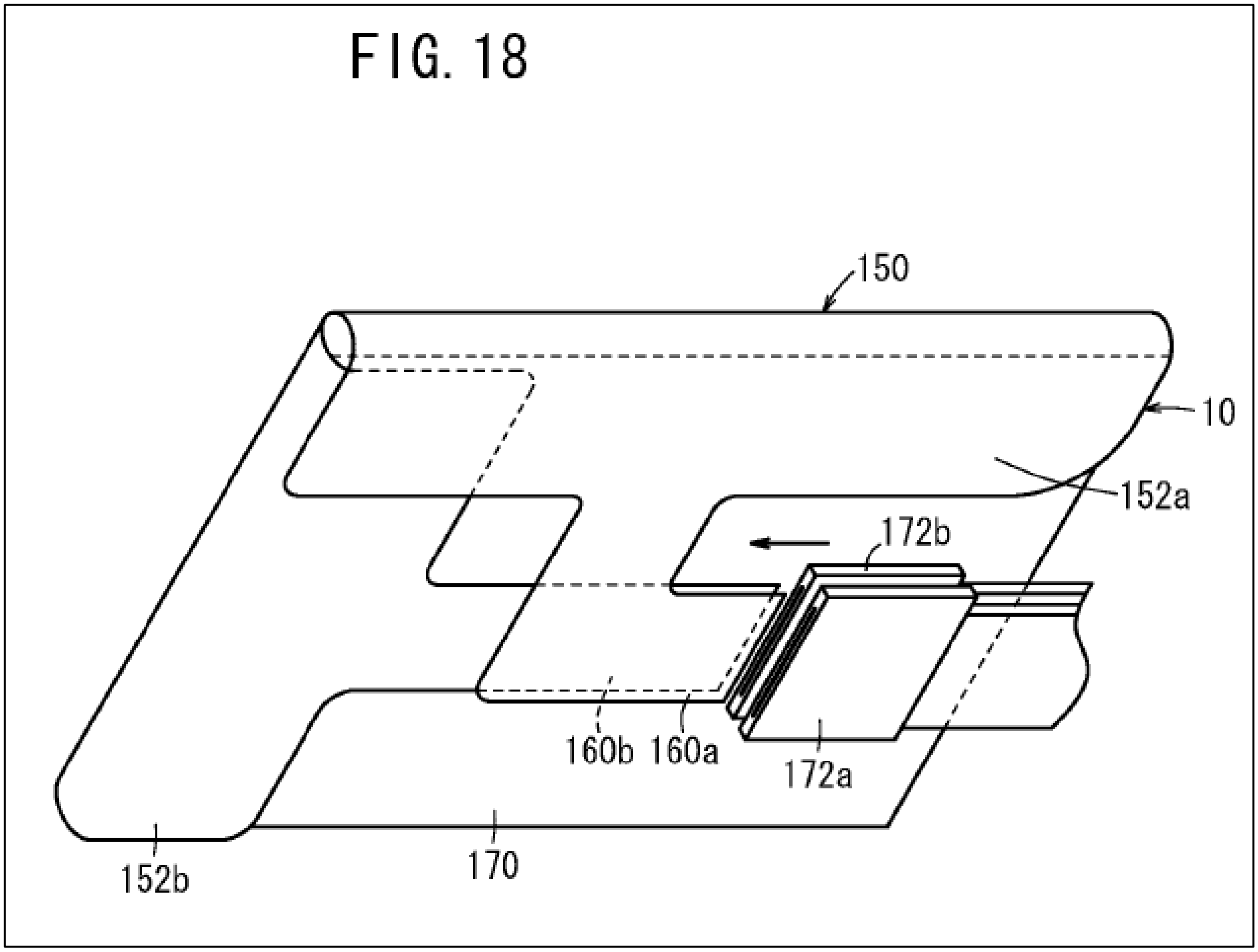


126. A POSITA would therefore have appreciated that Kuriki discloses this claim limitation.

1[e]/7[e]: "the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display"

127. Claims 1 and 7 state that "the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display."

128. To begin, I note that dependent claims 2 and 8 of the '311 patent require that "the touch sensor further comprises tracking disposed on the substantially flexible substrate configured to provide drive or sense connections to or from the drive or sense electrodes," and that the '311 patent describes this claimed "tracking" as the conductive line connections between the electrodes of the touch sensor and the controller circuitry, Ex. 1001 at 5:15-44. Accordingly, if the claim limitation "the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display" is understood to include scenarios where the "tracking" portion of the touch sensor (but not necessarily the touch-sensitive portion) is wrapped around one or more edges of a display, then a POSITA would understand this limitation to be taught by Kuriki alone. As discussed above, Kuriki explains that its "conductive sheet 10" includes "terminal wiring regions" on the PET transparent support 102, regions which are not only flexible but are "bent toward the back side of the sensing region **150** (i.e. the back side of the liquid crystal display panel **170**)" and ultimately wrapped around that LCD panel. Ex. 1003 at 21:8-12. Kuriki illustrates this in Fig. 18:



129. Accordingly, if this claim limitation is interpreted to only require that any portion of the touch sensor (including non-touch sensitive portions) be wrapped around the edge of a display, a POSITA would recognize this limitation to be clearly disclosed by Kuriki, which (as shown above) describes how the silver terminal wiring and the underlying PET substrate are bent around the edges of the LCD panel to be connected to the controller of the touch panel device.

130. Further, even if this claim limitation is understood to require that a touch-sensitive portions of the touch sensor be wrapped around one or more edges

of the display, a POSITA would have recognized that this limitation was still disclosed by the prior art—specifically, by Mikladal.

131. As discussed above, Mikladal disclosed a "capacitive touch sensitive film" (Ex. 1004 at 3:37-4:11) that is "formed as a flexible structure so as to allow bending thereof along a three dimensional surface" (Ex. 1004 at 3:37-4:11). In particular, Mikladal described how this touch-sensitive film could be "bent or formed" around the edges of a three-dimensional device to cover the different surfaces of that device, so that (as described in 7:31-44 of Ex. 1004):

> One sensing region can cover the area of a display to form a touch screen. Other sensing regions e.g. at the sides of the device can be configured to serve as touch sensitive element replacing the conventional mechanical buttons, e.g. the power button.

132. Accordingly, a POSITA would have recognized that Kuriki's touchscreen device could be modified so that its capacitive touch sensor would wrap around the edges of the underlying display onto the sidewalls of Kuriki's touch panel device, in order to create additional touch-sensitive display areas on the sides of Kuriki's device as taught by Mikladal.

133. A POSITA would certainly have been motivated to modify Kuriki in this manner for the reasons provided not only by Mikladal, but also several of the other contemporary prior art references discussed above. For example, as noted above, Mikladal itself specifically explains that the user of a flexible touch sensor

such as the one taught by Kuriki "opens entirely novel possibilities to implement touch sensing devices," because with a capacitive touchscreen that "cover[s] different surfaces of a three dimensional device, there can be several touch sensing regions for different purposes. One sensing region can cover the area of a display to form a touch screen. Other sensing regions e.g. at the sides of the device can be configured to serve as touch sensitive element[s] replacing the conventional mechanical buttons, e.g. the power button." Ex. 1004 at 7:31-44. Mikladal explains that this "provide[s] a superior freedom to the designers continuously trying to find functionally more versatile, smaller, cheaper, light, and also more visually attractive devices." Ex. 1004 at 1:8-20.

134. These motivations expressed by Mikladal are also explained by a number of other contemporary prior art references. For example, Brown (filed simultaneously with Mikladal by the same applicants) explains using this type of "touch sensitive film" would allow you to "replace[] the function of any mechanical buttons or switches used in prior art mobile phones," which would result in "technically improved functions" and "simplify and ameliorate the appearance of e.g. mobile phones." Ex. 1016 at 22:16-23:12. Joo explains that wrapping a flexible touch sensor around the edges of a display to create touch-sensitive portions on the side meant that "a separate side key is not required to be mounted at the side surface of the terminal for generating input, thereby simplifying the manufacturing process

thus to reduce the manufacturing cost and make the enhanced appearance of the terminal." Ex. 1008 at ¶¶ [0063]-[0067]. And Chen similarly notes the benefits that would result from modifying Kuriki in this manner. Ex. 1015 at 22:16–23:12.

135. Furthermore, it would have been straightforward for a POSITA to modify Kuriki in the manner described above—expanding the touch-sensitive portions of Kuriki's conductive sheet containing "lattice" electrodes to extend around the edge of Kuriki's display and onto the sidewalls of Kuriki's device, in order to create touch-sensitive portions on those sidewalls—and a POSITA would have readily expected success in and predictable results from making these modifications, for a number of reasons.

136. First, as discussed above, Kuriki and Mikladal both come from the same field of endeavor: the design of capacitive touch sensors for use in touchscreen devices. Ex. 1003 at 1:17-20; 18:35-53; Ex. 1004 at 3:34-40. Second, Kuriki's "conductive sheet" has the same basic structure (a conductive element formed on top of a substrate layer, both of which are then layered on top of an underlying display) as Mikladal's "touch sensitive film." Ex. 1003 at 12:9-13:9; 21:3-12; Ex. 1004 at 13:27-14:22; 2:28-44. Third, Kuriki and Mikladal disclose using the same materials in the same way for each of those layers in their touch sensors: extremely fine metal wires for the conductive layer, and polyethylene terephthalate (PET) for

the underlying substrate. Ex. 1003 at 23:3-23; 27:48-28:38; 29:55-30:33; Ex. 1004 at 12:10-25; 6:43-63.

137. Further, a POSITA would additionally have expected success in and predictable results from making the above-mentioned modifications to Kuriki due to the structural properties of Kuriki's conductive sheet, which were well-known in the prior art. Kuriki itself teaches that silver conductive lines (specifically, Kuriki's "terminal wiring patterns") and an underlying PET substrate on which those silver conductors were formed could be wrapped around an edge of a display. Ex. 1003 at 21:8-12. Further, a POSITA would have been well aware of the numerous other background prior art references describing how silver mesh electrodes (such as Kuriki's "lattice" electrodes) are flexible and capable of being bent around the edge of a device's display. Moran, for example, noted that a PET substrate bearing a silver mesh electrode would be "substantially planar and flexible." Ex. 1007 at 8:13-21. Similarly, U.S. Patent Application Publication No. US 2010/0123670, filed by the same assignee as that of the '311 patent (Atmel Corporation) noted that metals such as copper or silver can be used to form "mesh" electrodes which are "malleable" and "can be readily flexed or kinked without damage." Ex. 1012 at ¶¶ [0008]-[0009]. A 2010 paper by Hu et al. explained that "outstanding flexibility makes the Ag NW [silver nanowire] electrode attractive for flexible electronics," such as "capacitive touch screens." Ex. 1018 at 2955; 2962. And a U.S. patent

application filed in March 2011 by Winoto et al. similarly noted the "favorable physical and mechanical properties" of "robust and flexible" silver nanowire matrices for use in "touch screens." Ex. 1019 at ¶¶ [0025]; [0033]; [0081].

7[f]: "one or more computer-readable non-transitory storage media embodying logic that is configured when executed to control the touch sensor."

138. Kuriki explains that the lattices of its touch sensor are "electrically connected" by the "terminal wiring" "to an IC circuit for position calculation, etc.," in which "[t]he finger touch position is calculated in the IC circuit based on the transmitted signals." Ex. 1003 at 18:35-53; 21:8-17. A conventional capacitive touch sensing IC at the time would have included computer-readable non-transitory storage media embodying logic that is configured when executed to control the touch sensor. Accordingly, a POSITA would have appreciated that this claim limitation was disclosed by Kuriki.

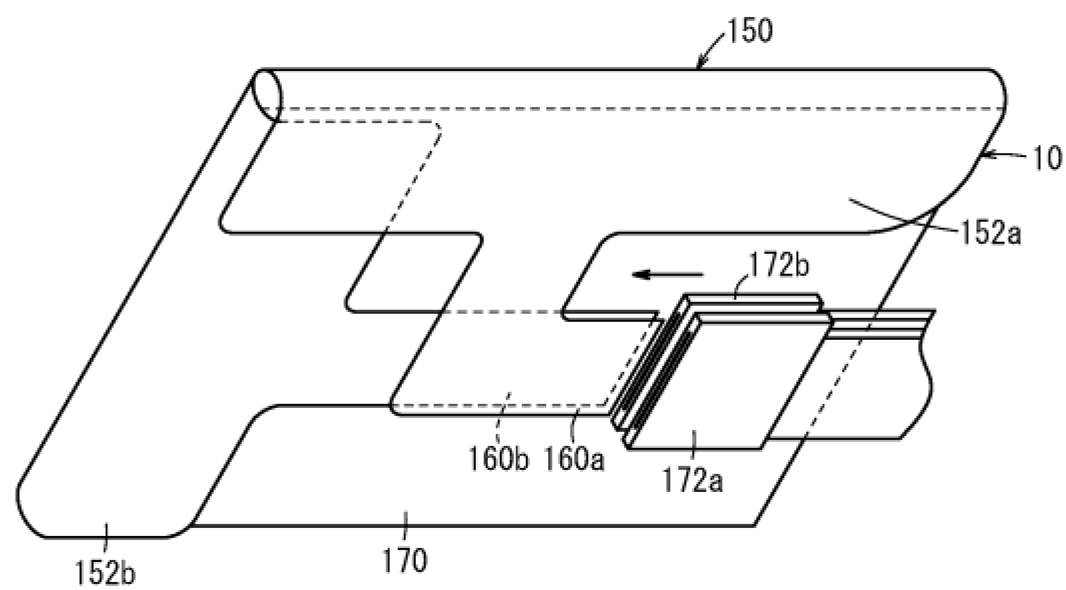
139. I further note that the '311 patent itself discloses that "a computer-readable storage medium may include a semiconductor-based or other ICs," Ex. 1001 at 8:11-34—such as the IC circuit disclosed by Kuriki. Mikladal, too, explains that "processing means" such as the IC circuit taught by Kuriki "can comprise any hardware and electronics as well as software tools for generating and controlling signals needed in operating the touch sensitive film." Ex. 1004 at 8:14–26.

7.2. Claims 2 and 8

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor further comprises tracking disposed on the substantially flexible substrate configured to provide drive or sense connections to or from the drive or sense electrodes and configured to bend with the substantially flexible substrate."

140. Kuriki teaches that in addition to its silver "lattices" formed on the PET transparent support, "terminal wiring patterns" 42a/42b made of silver are also formed on the transparent support, and then wrapped around the edges of the LCD panel (along with the PET transparent support on which those terminal wiring patterns are formed). Ex. 1003 at 11:64-12:8; 19:64-21:12; 27:48-28:38; 29:55–30:33. This is depicted in Fig. 18 of Kuriki:

FIG. 18



141. Kuriki further explains that these terminal wiring patterns 42a/42b (which correspond to the claimed "tracking"), after being wrapped around the edges of the LCD, are "electrically connected to an IC circuit for position calculation, etc." by "connectors 172a, 172b." Ex. 1003 at 21:13-17; 18:35-53. I note that the '311 patent similarly explains that its "tracks 14" connect a "controller 12" to the electrodes of the '311 patent's touch sensor. Ex. 1001 at 5:15-55. Accordingly, a POSITA would have appreciated that this claim limitation was disclosed by Kuriki.

7.3. Claims 3 and 9

> **"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are made from one of carbon nanotubes, copper, silver, a copper-based material, or a silver-based material."**

142. A POSITA would have appreciated that this claim limitation was disclosed by Kuriki, which discloses that the conductive lines of its "lattices" are manufactured from metallic silver, a silver-based material. Ex. 1003 at 27:48-28:38, 29:55-30:33.

7.4. Claims 4 and 10

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor comprises: a single-layer configuration with drive and sense electrodes disposed only on a first surface of the substantially flexible substrate; or a two-layer configuration with drive electrodes disposed on the first surface of the substantially flexible substrate and sense electrodes disposed on a second surface of the substrate opposite the first surface."

143. A POSITA would have understood that Kuriki discloses the claimed two-layer configuration with drive electrodes disposed on the first surface of the substantially flexible substrate, and sense electrodes disposed on a second surface of the substrate opposite the first surface. This is because Kuriki teaches a two-layer configuration for its touch sensor, where a checkerboard-like pattern 26A of a first group of "large lattice" electrodes is created on one side 102a of the PET "transparent support" substrate 102, and a second checkerboard-like pattern 26B of a second group of "large lattice" electrodes is created on the other side 102b of that PET transparent support 102. Ex. 1003 at 11:57-12:25; 11:51-56 ("an electrode for a touch panel or the like can be easily formed" from "the same or different patterns . . . on each side (each of front and back sides) of one transparent support 102"). This two-layer configuration is illustrated in Figs. 9, 10, and 12 of Kuriki:

FIG. 9

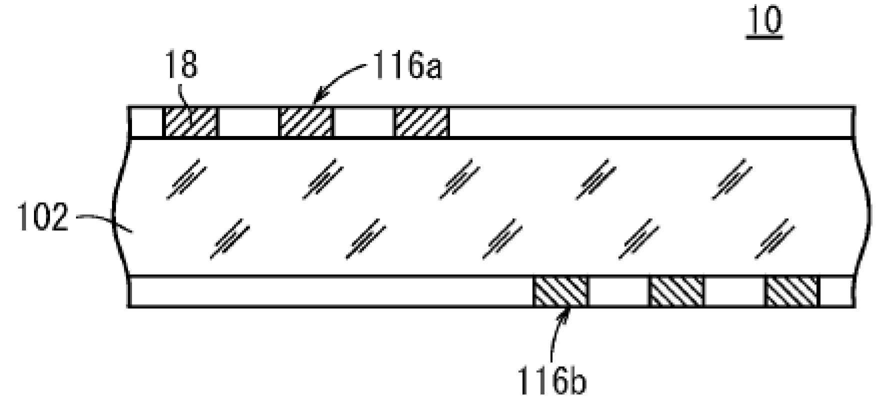
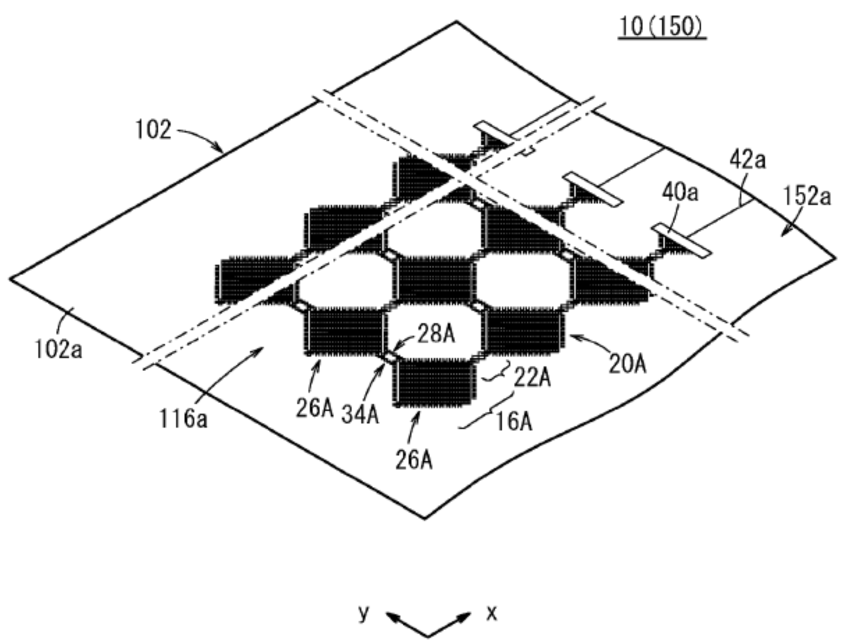
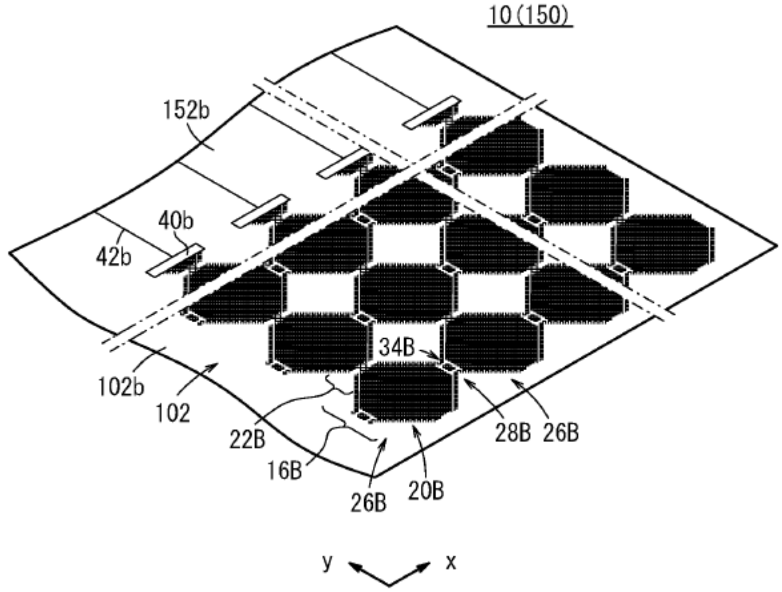

10
18
116a
102
116b

FIG. 10


10(150)
102
42a
40a
152a
102a
28A
20A
22A
116a
26A
34A
16A
26A
y
x



144. A POSITA would have recognized that these “conductive patterns” 26A/B made up of large lattices 16A/16B on either side of the PET transparent support 102 disclose the “drive or sense electrodes” that form “a plurality of capacitive nodes,” as independent claims 1 and 7 of the ’311 patent require.

145. Further, a POSITA would also have recognized that a capacitive touch sensor that utilizes a two-layer electrode configuration, like the one disclosed by Kuriki, would commonly have drive electrodes in one layer and sense electrodes in the other layer. I note that in a separate international patent application that was filed by the same named inventor as listed in Kuriki, that inventor disclosed using the same type of “lattice” electrodes found in Kuriki (Ex. 1017 at 16:30-25:18) in a two-layer “mutual capacitance” type sensor, where “voltage signal for the touch position

detection is sequentially supplied to the first conductive patterns 22A"—the drive electrodes—" and the second conductive patterns 22B are sequentially subjected to sensing"—the sense electrodes. Ex. 1017 at 26:5-10. Therefore, it would have been obvious to a POSITA that the projected capacitance sensor disclosed by Kuriki would be used in a two-layer mutual-capacitance configuration where one layer is the drive electrodes and the other layer is the sense electrodes.

7.5. Claims 5 and 11

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor is a mutual-capacitance touch sensor or a self-capacitance touch sensor."

146. A POSITA would have understood that Kuriki disclosed mutual-capacitance touch sensors as well as self-capacitance touch sensors. As discussed above, it would have been clear to a POSITA that Kuriki's invention is directed towards capacitive touch sensors:

- Kuriki states that "The present invention relates to a method for producing a conductive sheet (for example suitable for use in a projected capacitive touch panel)," Ex. 1003 at 1:16-20;

- Kuriki also states that "the first large lattices 16A"—referring to the "lattice" electrodes discussed at length above—"exhibit a lowered electrostatic capacitance in the detection process," Ex. 1003 at 12:26-39;

- Kuriki explains that its "projective capacitive touch panel" works by "sensing change in an electrostatic capacitance between a human finger and a conductive film

to detect the position touched by the fingertip," Ex. 1003 at 1:35-40; and

- That "when a finger comes into contact" with Kuriki's touch panel, "signals are transmitted from the first conductive pattern **26A** and the second conductive pattern **26B** corresponding to the finger touch position to the IC circuit. The finger touch position is calculated in the IC circuit based on the transmitted signals." Ex. 1003 at 18:46-53.

147. As I noted above, the named inventor of Kuriki (Kuriki himself) confirmed (in a separate international application) that the "lattice" electrodes described by the Kuriki patent are capable of being used in both mutual-capacitance and self-capacitance implementations for touchscreen sensors. That international application explains that the "lattice" electrodes disclosed by Kuriki are capable of being used in both "self or mutual capacitance" variants. Ex. 1017, 16:30-25:18 (discussing the "lattice" electrodes found in Kuriki); 25:19-26:29 (disclosing that Kuriki's "lattice" electrodes can be used in either "self or mutual capacitance" scenarios).

7.6. Claims 6 and 12

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor further comprises electrically-isolated structures made of conductive material comprising a conductive mesh."

148. A POSITA would have appreciated that this claim limitation was disclosed by Kuriki. Kuriki explains that "electrically isolated" "insulation patterns" (28A/34A/36A and 28B/34B/36B in Figs. 10-14 of Kuriki) of lattice which are

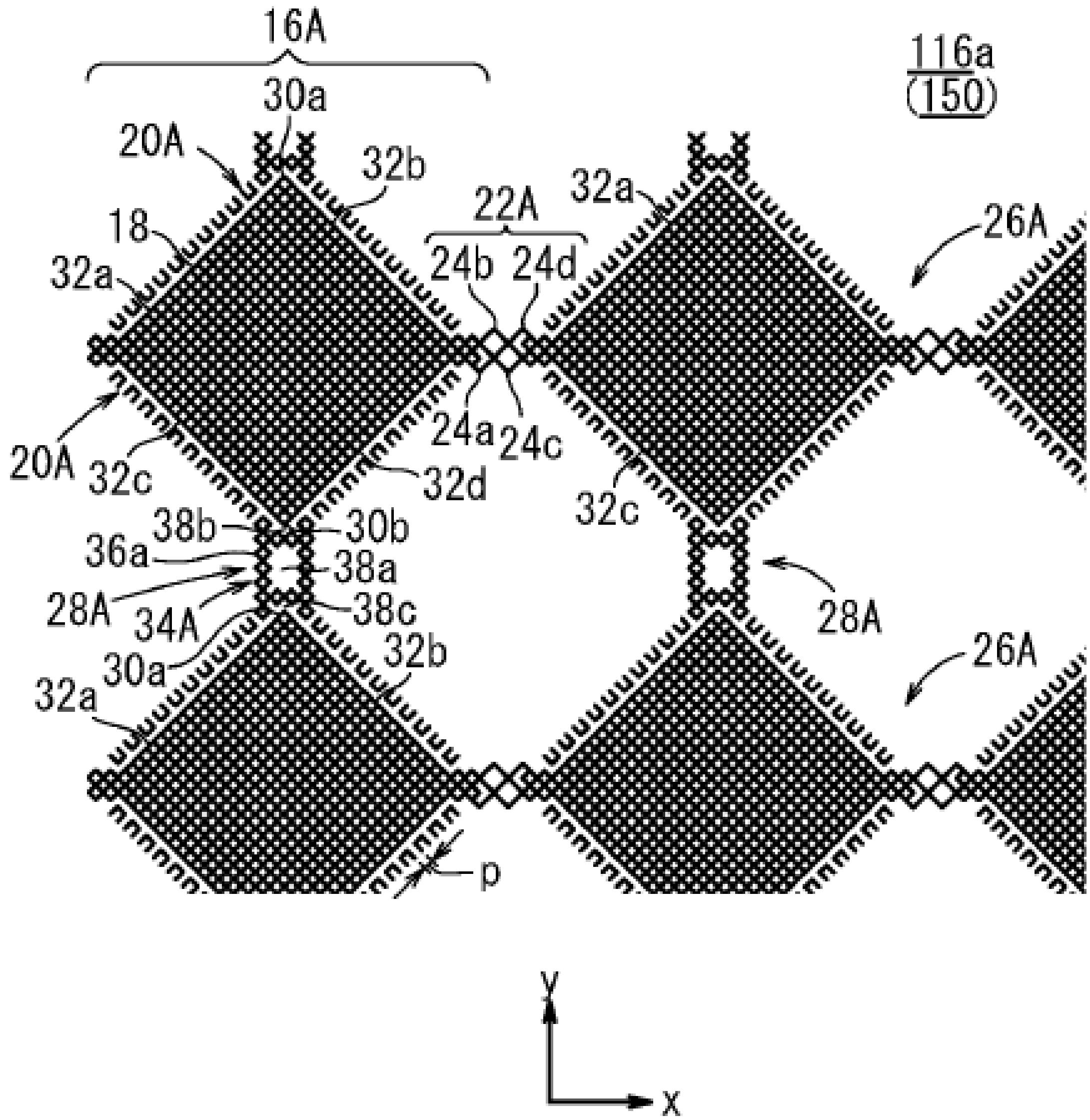
"unconnected" to the lattice electrodes of Kuriki's touch sensor, are "disposed between" the conductive lattices of the touch sensor. Fig. 1003 at 12:40-46; 12:64-13:3; 13:63-67; 15:60-67. These "insulation patterns," Kuriki discloses, are "composed of a plurality of the small lattices 18." Ex. 1003 at 13:63-14:14; 15:60-16:7.

7.7. Claims 13 and 16

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are substantially orthogonal to one another."

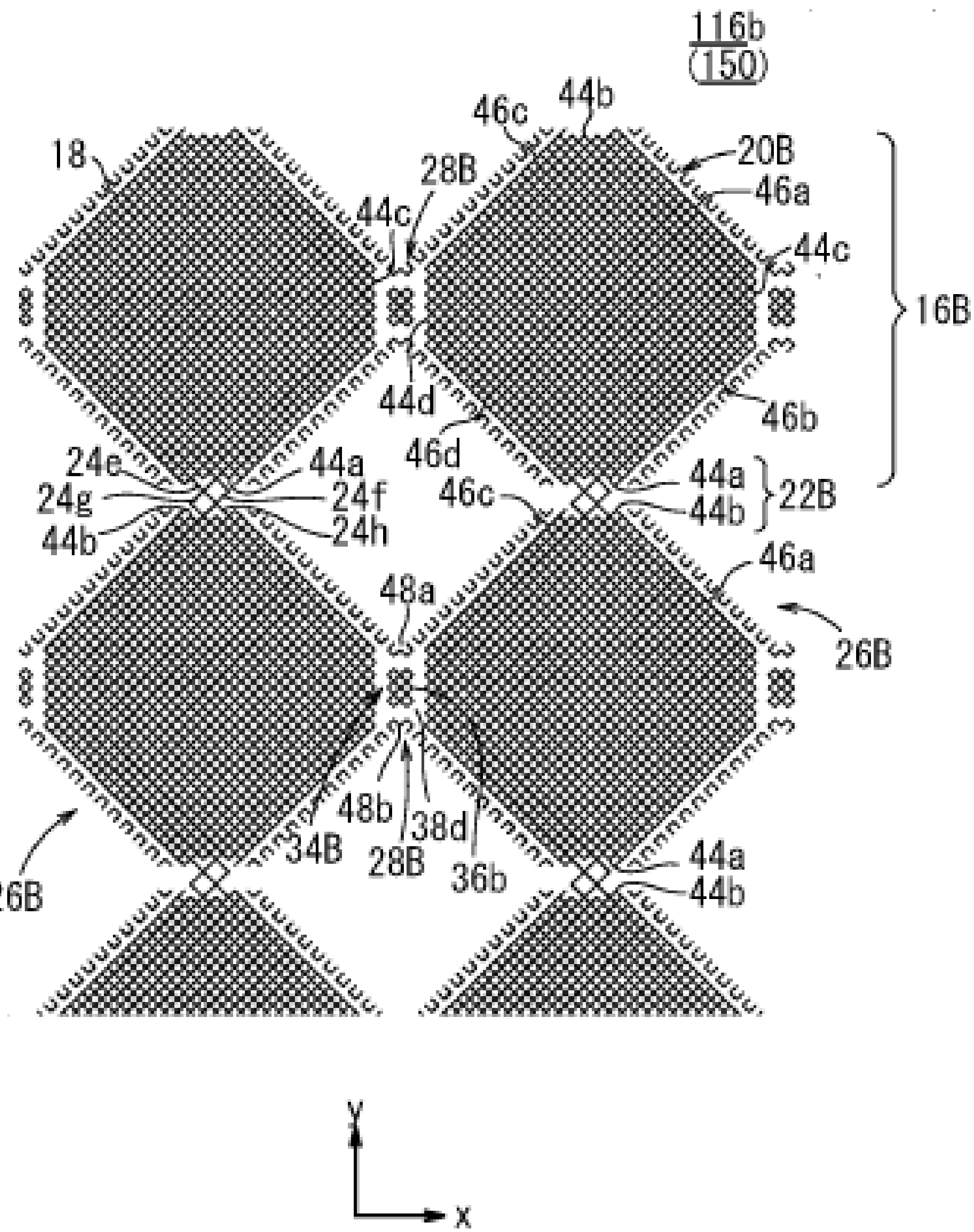
149. A POSITA would have understood that Kuriki disclosed this claim limitation. Specifically, Figures 11 and 13 of Kuriki illustrate how the silver conductive lines that make up Kuriki's "lattices" 16A/16B are orthogonal to one another:

FIG. 11



16A
116a
(150)
30a
20A
32b
22A
32a
18
24b
24d
26A
32a
24a
24c
20A
32c
32d
32c
38b
30b
36a
38a
28A
38c
28A
34A
30a
32b
26A
32a
p
y
x

FIG. 13



116b
(150)
44b
46c
18
28B
20B
46a
44c
44c
16B
44d
46b
46d
24e
44a
44a
24g
24f
46c
22B
44b
24h
44b
46a
48a
26B
48b
38d
34B
28B
36b
44a
44b
26B
Y
X

7.8. Claims 15 and 18

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are made of fine lines of metal having a thickness of approximately 5 micrometers or less and a width of approximately 10 micrometers or less."

150. Kuriki explains, in regards to the conductive silver lines in its touch sensor's "lattices," that the "line width of each conductive pattern is . . . most preferably 5 to 9 μm." Ex. 1003 at 29:10-13. Additionally, Kuriki discloses that "the thickness of the layer of the conductive metal on the conductive pattern is . . . preferably 0.1 μm or more but less than 3 μm." Ex. 1003 at 30:8-15. Accordingly, a POSITA would have understood that Kuriki discloses this claim limitation.

8. THE COMBINATION OF KURIKI, MIKLADAL, AND PHILIPP

151. Philipp also comes from the same field of endeavor as Kuriki and Mikladal—the design of capacitive touch sensors for use in touchscreen devices. And Philipp addresses the same problem as Kuriki and Mikladal: the design of transparent capacitive sensors that can be layered over a device's display screen and used to create a touchscreen capable of controlling that device. A POSITA would therefore have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

152. The particular combinations of Kuriki, Mikladal, and Philipp's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis

indicates that a POSITA would have had motivation to combine the features in Kuriki, Mikladal, and Philipp to arrive at what is claimed in the ’311 patent based on the disclosures in the prior art and that POSITA’s knowledge of the art.

8.1. Claims 14 and 17

“The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are non-linear.”

153. Kuriki discloses that the *sides* of its lattices “may have a straight line shape, a curved shape, or an arc shape . . . each side may have a wavy shape containing outwardly protruding arcs and inwardly protruding arcs formed continuously . . . [or] a sine curve shape.” Ex. 1003 at 18:54-64. However, Kuriki does not expressly disclose that the *internal* lines of its “lattice” electrodes are non-linear.

154. As a POSITA would have recognized, however, Philipp discloses this claim limitation. Philipp describes mesh electrodes with internal conductive lines that are “wavy lines . . . formed of a series of curves,” which “avoid creating moiré patterns when overlaying a display” and “long linear stretches of fine metal line.” Ex. 1005 at ¶¶ [0030]; [0041]-[0045]. These non-linear, wavy lines are depicted in Fig. 4 of Philipp:

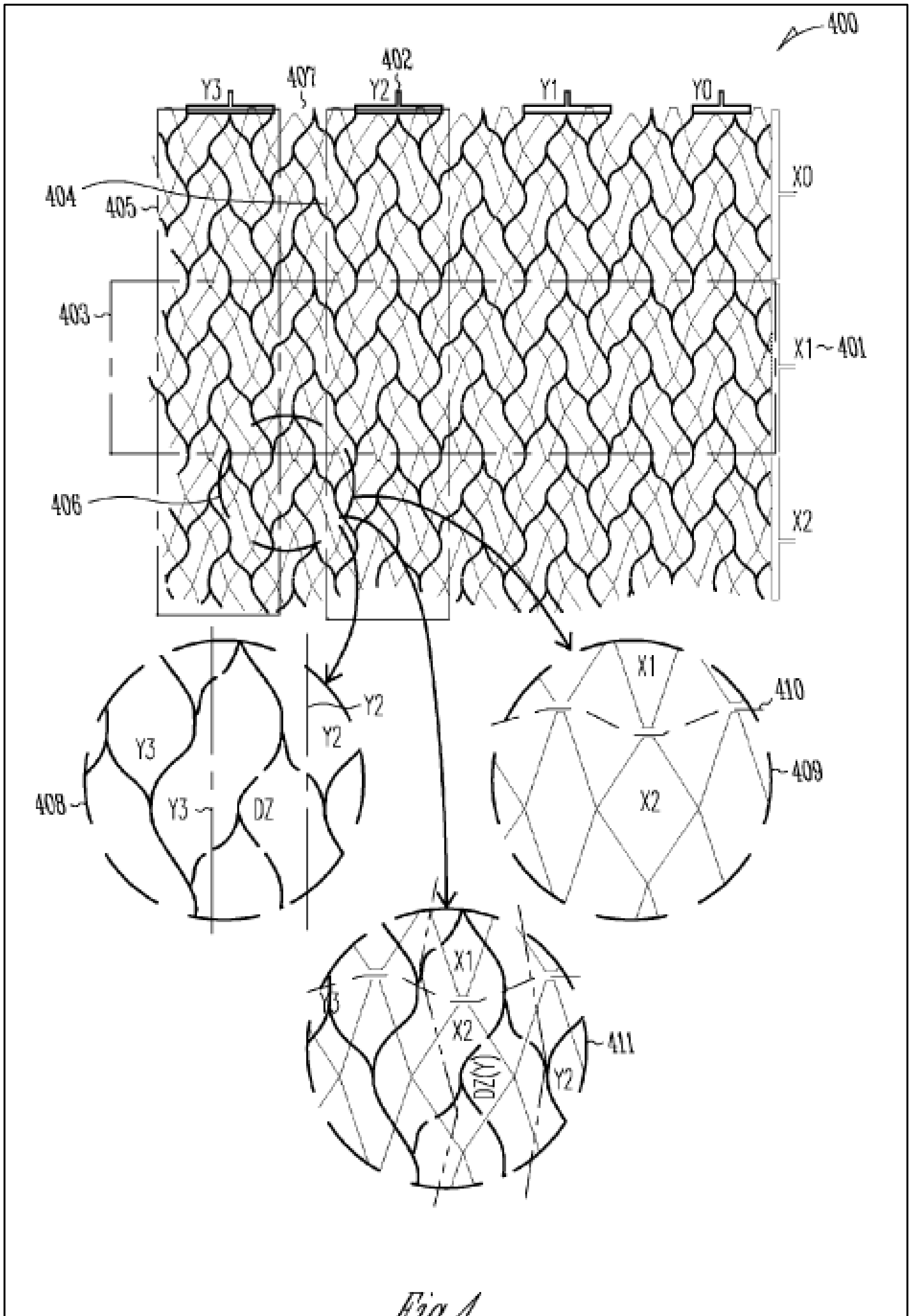


Fig. 4

155. A POSITA would have understood that Kuriki's "lattice" electrodes could be modified to use "wavy," non-linear lines such as those utilized in Philipp's electrodes, instead of the straight, orthogonal lines depicted by Kuriki's figures. And

a POSITA would have been motivated to modify Kuriki in this manner to solve the problem that Philipp identifies as remedied by this modification: "to avoid creating moiré patterns between the display and the touchscreen." Ex. 1005 at Abstract. Indeed, Philipp specifically notes that "wavy lines are used to avoid long linear stretches of fine metal line, reducing the probability of causing interference patterns."[5] Ex. 1005 at ¶¶ [0030]-[0031]. Kuriki notes this same problem as well, warning about "moire [being] significantly generated due to the conductive metal portion," which Kuriki notes can cause "the touch panel using the conductive pattern [to have] a poor visibility." Ex. 1003, 29:10–28.

156. Additionally, it would have been straightforward for a POSITA to use Philipp's teachings to modify Kuriki in this manner (incorporating wavy, non-linear lines into Kuriki's "lattice" electrodes. As discussed above, Philipp, just like Kuriki, comes from the same field of endeavor—designing "mesh" electrodes to be incorporated into capacitive touchscreen sensors. Ex. 1005 at ¶¶ [0018]-[0019]; [0042]. And Kuriki already discloses the use of curved, non-linear conductive lines of metallic silver on the outside of its "lattice" electrodes, expressly noting that "each side of the small lattice **18** may have a straight line shape, a curved shape, or an arc

---

[5] The term "interference patterns" as used here refers to optical interference that is visible to a user, often called "moire."

shape . . . each side may have a wavy shape containing outwardly protruding arcs, and inwardly protruding arcs formed continuously . . . [or] a sine curve shape." Ex. 1003 at 18:54-64. Accordingly, a POSITA would have readily expected success in and predictable results from making this straightforward modification.

9. THE COMBINATION OF KURIKI, MIKLADAL, AND RAPPOPORT

157. Rappoport, like Kuriki and Mikladal, is directed to touchscreen devices with capacitive touch sensors, as discussed further below. Further, Rappoport, just like Kuriki, discusses the manufacture of touchscreen devices that incorporate conductive metal lines into their display. A POSITA would therefore have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

158. The particular combinations of Kuriki, Mikladal, and Rappoport's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis indicates that a POSITA would have had motivation to combine the features in Kuriki, Mikladal, and Rappoport to arrive at what is claimed in the '311 patent based on the disclosures in the prior art and that POSITA's knowledge of the art.

9.1. Claims 19 and 20

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines of the flexible conductive material of the drive or sense electrodes is wider at the one or more edges of the display."

159. As noted above, the combined teachings of Kuriki and Mikladal disclose wrapping the flexible conductive lines of mesh electrodes around the edge of a display. However, Kuriki and Mikladal do not expressly disclose that the width (or other dimensions) of these conductive lines are varied at the edge of the display.

160. A POSITA would have recognized that Rappoport discloses this claim limitation. Rappoport describes a touchscreen device where, at the edges, "[c]onductive traces . . . such as control lines 62" "formed on the surface of [a] substrate 60" have been "enlarged (e.g. widened and/or thickened) in the vicinity of bend axis 56" at the edge of the device where those conductive lines are bent. Ex. 1006 at ¶¶ [0038]-[0043]. Rappoport illustrates this technique in Figs. 7-9:

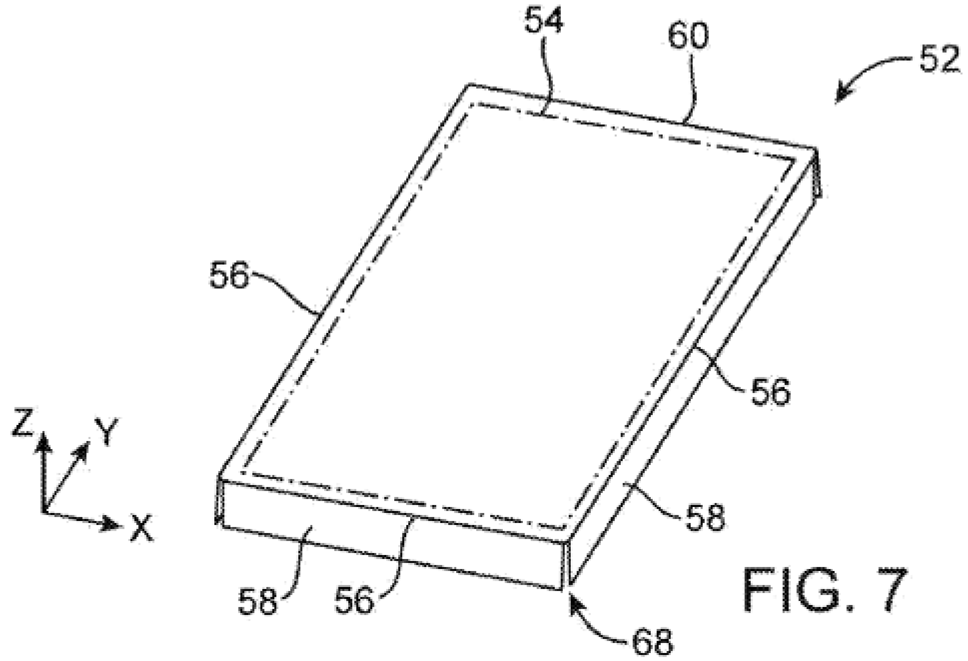


FIG. 7

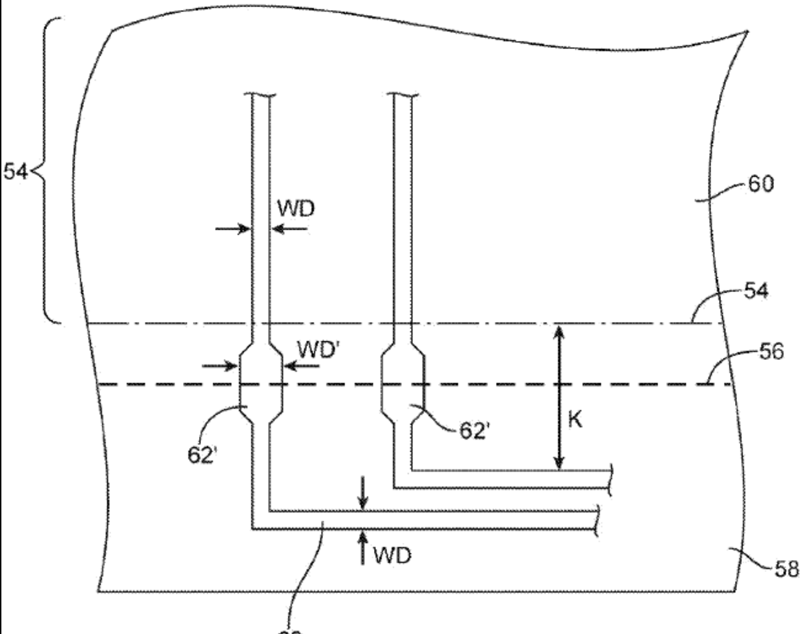


FIG. 8

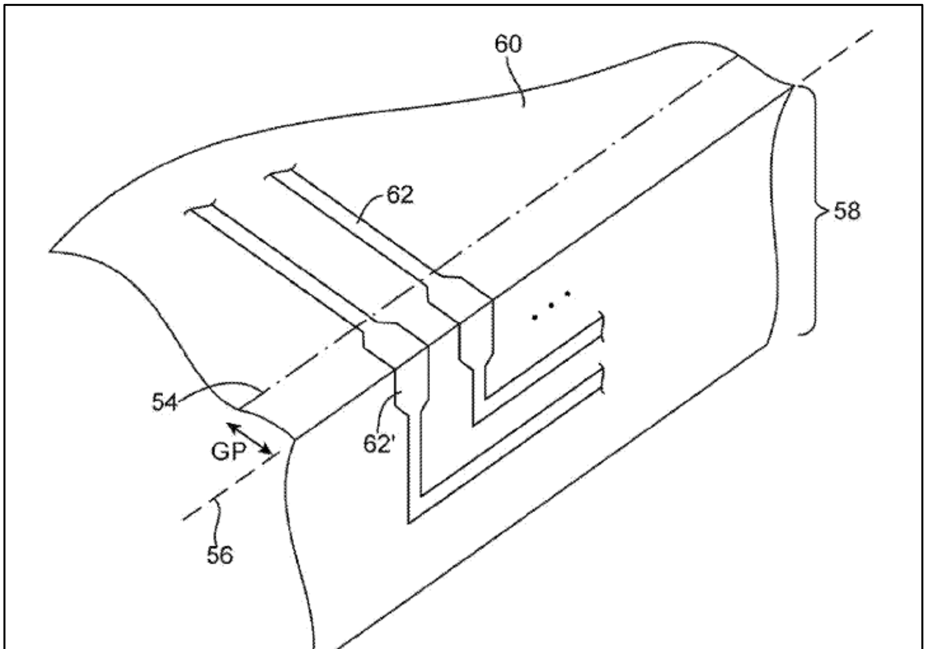


FIG. 9

161. Accordingly, a POSITA would have recognized that when Kuriki's "conductive sheet" and the "lattice" electrodes on it were extended to wrap around the edges of Kuriki's touchscreen device and onto its sides, as taught by Mikladal, the conductive metal lines located at the edges of that device could be made wider, as taught by Rappoport.

162. A POSITA would have been motivated to use Rappoport's technique in Kuriki's flexible touchscreen device for the reason provided by Rappoport: to "help ensure that traces 62 are not cracked or otherwise damaged" when wrapped around the edge of the device. Ex. 1006 at ¶ [0043].

163. Further, it would have been straightforward for a POSITA to use Rappoport's teachings to modify the combination of Kuriki and Mikladal in this way

(to widen the conductive lines of Kuriki's mesh electrodes at the edges of the device's display, where those lines would be bent). As discussed above, Rappoport, like Kuriki, is discussing the use of fine conductive lines at the edges of a touchscreen display. Ex. 1006 at ¶¶ [0029]; [0049]. Further, Kuriki already discloses varying the width of the silver conductive lines in its conductive sheet, disclosing that "the first terminal wiring patterns 42a farthest from the center of the arrangement of the first conductive patterns 26A may have the largest line width, and the first terminal wiring pattern 42A closer to the arrangement center may have a smaller line width." Ex. 1003 at 21:55-65. Accordingly, a POSITA would have readily expected success in and predictable results from making this straightforward modification.

10. THE COMBINATION OF MORAN AND JOO

164. Moran and Joo each come from the same field of endeavor—the design of touch sensors for use in touchscreen devices. And both Moran and Joo address the same problem: the design of transparent sensors that can be layered over a device's display screen and used to create a touchscreen capable of controlling that device. A POSITA would therefore have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

165. The particular combinations of Moran and Joo's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis indicates that a POSITA would have had motivation to combine the features in Moran and Joo to arrive at what is claimed in the '311 patent based on the disclosures in the prior art and that POSITA's knowledge of the art.

10.1. Claims 1 and 7

1[preamble]/7[preamble]: "An [apparatus/device] comprising:"

166. Moran discloses a capacitive touchscreen sensor apparatus or device. More specifically, Moran describes "contact or proximity sensors for touch input of information or instructions into electronic devices (e.g., computers, cellular telephones, etc.)"—and, in particular, a "'touch screen' sensor." Ex. 1007 at 6:7-11. Accordingly, a POSITA would have appreciated that Moran discloses this claim limitation.

1[a]/7[a]: "a substantially flexible substrate"

167. A POSITA would have recognized that Moran disclosed this claim limitation. Moran describes a "light transparent substrate 130" made of PET. Ex. 1007 at 7:16-26. Moran goes onto describe sensors made using this PET substrate as "substantially planar and flexible." Ex. 1007 at 8:13–16. Further, as I have

repeatedly discussed above, PET is the only example that the '311 patent gives as an example of a "suitable material" for the claimed substrate. Ex. 1001 at 2:38-40.

1[b]/7[b]: "a touch sensor disposed on the substantially flexible substrate"

168. A POSITA would have understood that Moran also discloses a touch sensor disposed on the substantially flexible substrate (Moran's PET "light transparent substrate"). Moran's touch sensor is what Moran describes as "at least two electrically conductive micropatterns disposed on or in the visible light transparent substrate." Ex. 1007 at 4:18-26. These conductive micropatterns are connected to a controller that "driv[es] the conductive micropatterns with electrical signals for the purpose of capacitively detecting the presence or location of a touch event to an information display." Ex. 1007 at 6:7-26. "The substrate and the sensor may be substantially planar and flexible." Ex. 1007 at 6:15-16.

1[c]/7[c]: "the touch sensor comprising [drive or sense electrodes/a plurality of capacitive nodes formed from drive or sense electrodes] made of flexible conductive material configured to bend with the substantially flexible substrate"

169. As discussed above, this claim limitation contains two separate sub-limitations: (1) that the touch sensor comprises "drive or sense electrodes" or a "plurality of capacitive nodes formed from drive or sense electrodes"; and (2) that those electrodes are "made of flexible conductive material configured to bend with

the substantially flexible substrate." A POSITA would have recognized that both of these sub-limitations were disclosed by Moran, as I discuss below.

drive or sense electrodes / a plurality of capacitive nodes formed from drive or sense electrodes

170. As noted above, Moran explains that "both conductive micropatterns form at least a portion of a touch sensor, for example a touch screen sensor." Ex. 1007 at 9:6-7. A POSITA would have readily understood that each pair of conductive micropatterns in Moran (Ex. 1007 at 6:27-26) consists of a drive electrode and sense electrode that together form a capacitive node, as recited by the claims. In fact, Moran notes that the circuitry to which its micropatterns are connected "drive[s]" selected micropatterns (this is describing the claimed "drive electrodes") and "measure[s]" other selected micropatterns (describing the claimed "sense electrodes"), allowing Moran's controller to "make mutual capacitance measurements of the transparent sensor element." Ex. 1007 at 32:21-29. In fact, another of the 3M patent applications that I discuss above, Frey I, refers to the "conductive micropatterns" of Moran as "electrodes." Ex. 1013 at ¶¶ [0110]; [0117].

made from flexible conductive material configured to bend with the substantially flexible substrate

171. A POSITA would have also recognized that Moran disclosed this sub-limitation of the claims as well. Moran discloses that the lines that make up its conductive micropatterns are manufactured from metals such as copper or silver.

Ex. 1007 at 22:13-15. Further, Moran also explains that these metals, when disposed in micropatterns on a PET substrate, result in a touch sensor that is "substantially planar and flexible." Ex. 1007 at 8:13-16. "The substrate and the sensor may be substantially planar and flexible." Ex. 1007 at 6:15-16.

172. Additionally, as discussed above, a POSITA would have been well aware from other contemporary prior art references that silver, as utilized in this reference, is an inherently flexible conductive material that would bend along with a PET substrate. U.S. Patent Application Publication No. US 2010/0123670, filed by the same assignee as that of the '311 patent (Atmel Corporation) noted that metals such as copper or silver can be used to form "mesh" electrodes which are "malleable" and "can be readily flexed or kinked without damage." Ex. 1012 at ¶¶ [0008]-[0009]. A 2010 paper by Hu et al. explained that "outstanding flexibility makes the Ag NW [silver nanowire] electrode attractive for flexible electronics," such as "capacitive touch screens." Ex. 1018 at 2955; 2962. A U.S. patent application filed in March 2011 by Winoto et al. similarly noted the "favorable physical and mechanical properties" of "robust and flexible" silver nanowire matrices for use in "touch screens." Ex. 1019 at ¶¶ [0025]; [0033]; [0081]. And as discussed above, Kuriki discloses that silver wiring on a PET substrate can be wrapped around the edges and onto the back of a LCD panel. Ex. 1003 at 21:8-12; 27:48-28:38; 29:55–30:33).

1[d]/7[d]: "the flexible conductive material of the drive or sense electrodes comprises first and second conductive lines that electrically contact one another at an intersection to form a mesh grid"

173. A POSITA would have recognized that this claim limitation, too, was disclosed by Moran. Moran explains that "preferred conductive micropatterns include regions with two dimensional meshes (or simply, meshes), where a plurality of linear micropattern features (often referred to as conductor traces or metal traces) such as micropatterned lines define enclosed open areas within the mesh." Ex. 1007 at 9:17-22. Moran provides a visual example of a conductive micropattern with first and second conductive lines intersecting to form a mesh grid in Fig. 2:

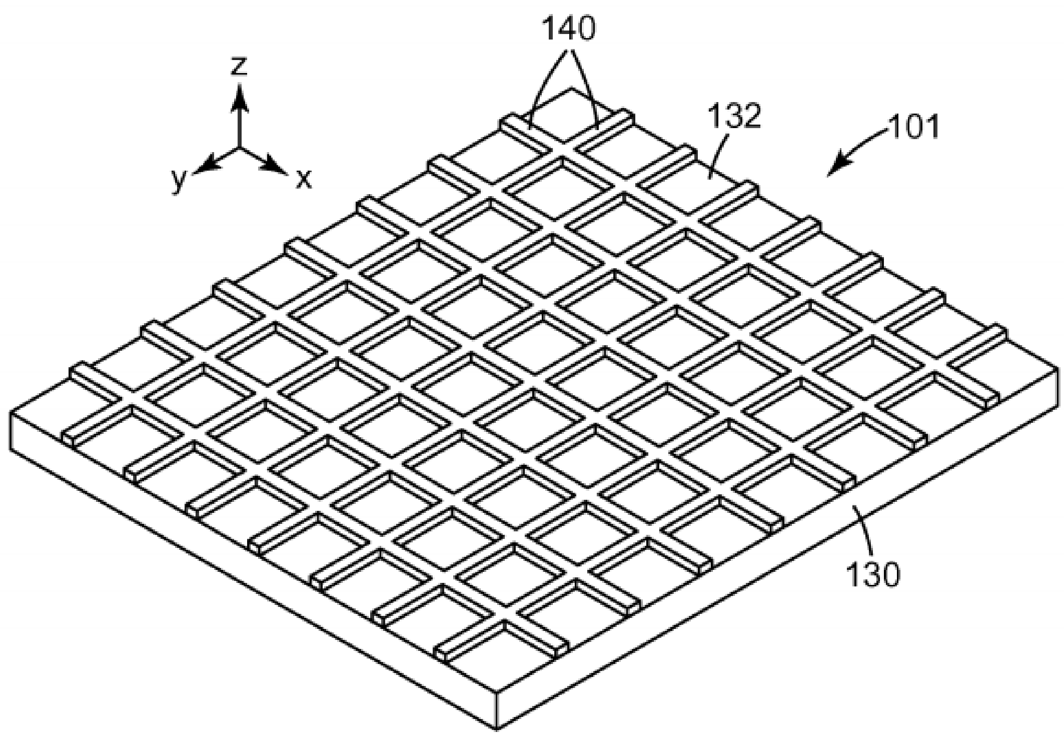


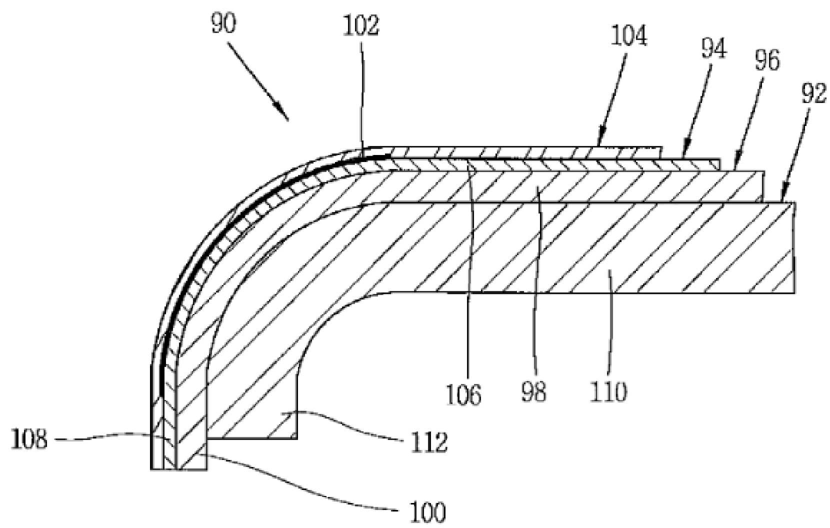
Fig. 2

1[e]/7[e]: "the substantially flexible substrate and the touch sensor are configured to wrap around one or more edges of a display"

174. Although Moran discloses, as discussed above, that its transparent PET substrate and the silver/copper micropatterns formed on that substrate are "substantially planar and flexible" (Ex. 1007 at 5:17-19; 8:15-16) it does not explicitly disclose that the PET substrate and the touch sensor upon it are wrapped around one or more edges of a display.

175. Joo, however, does disclose wrapping a substrate and a touch sensor disposed on that substrate around the edge of a display. As discussed above, Joo teaches a "support member 96," which is "formed of a transparent material, such as a polycarbonate material." Ex. 1008 at ¶¶ [0042]; [0053]; [0061]. On that support member 96 is layered "touch input portion 94," and both the support member and touch input portion are in turn layered on top of "display unit 92." Ex. 1008 at ¶¶ [0060]-[0063]. This structure is illustrated by Fig. 7 of Joo:

FIG. 7



176. Joo further describes how "display unit 92 is bent at the edge of the upper display portion **110** in the form of a curved surface, thereby forming a side display portion **112**." Ex. 1008 at ¶ [0063]. Joo explains that because "the touch input portion for generating input when being touched is extendingly formed at the side surface portion of the cover as well as the upper surface portion thereof . . . a separate side key is not required to be mounted at the side surface of the terminal for generating input, thereby simplifying the manufacturing process thus to reduce the manufacturing cost and make the enhanced appearance of the terminal." Ex. 1008 at ¶ [0067].

177. Accordingly, a POSITA would have understood that Moran's touchscreen device could be modified so that the capacitive touch sensor would wrap around the edges of the underlying display onto the sides of Moran's touchscreen device, in order to create touch-sensitive display regions on the sides of Moran's device (as Joo teaches).

178. A POSITA would have been motivated to modify Moran in this way for the reasons expressly provided by Joo as well as the reasons disclosed by the other contemporary prior art references discussed above. Joo itself notes that wrapping a flexible touch sensor around the edges of a display to create touch-sensitive portions on the side meant that "a separate side key is not required to be mounted at the side surface of the terminal for generating input, thereby simplifying the manufacturing process thus to reduce the manufacturing cost and make the enhanced appearance of the terminal." Ex. 1008 at ¶¶ [0063]-[0067].

179. Further, Mikladal describes how the use of a flexible touch sensor such as the one taught by Moran "opens entirely novel possibilities to implement touch sensing devices," because with a capacitive touchscreen that "cover[s] different surfaces of a three dimensional device, there can be several touch sensing regions for different purposes. One sensing region can cover the area of a display to form a touch screen. Other sensing regions e.g. at the sides of the device can be configured to serve as touch sensitive element[s] replacing the conventional mechanical buttons,

e.g. the power button." Ex. 1004 at 7:31-44. Mikladal explains that this "provide[s] a superior freedom to the designers continuously trying to find functionally more versatile, smaller, cheaper, light, and also more visually attractive devices." Ex. 1004 at 1:8-20. Brown (filed simultaneously with Mikladal by the same applicants) explained using this type of "touch sensitive film" would allow you to "replace[] the function of any mechanical buttons or switches used in prior art mobile phones," which would result in "technically improved functions" and "simplify and ameliorate the appearance of e.g. mobile phones." Ex. 1016 at 22:16-23:12. Chen similarly noted the benefits that would result from modifying Moran in this manner. Ex. 1015 at 22:16–23:12.

180. Furthermore, it would have been straightforward for a POSITA to modify Moran in the manner described above— expanding the touch-sensitive portions of Moran's capacitive touchscreen containing mesh conductive micropatterns to extend around the edge of Moran's underlying display and onto the sidewalls of Moran's device, in order to create touch-sensitive portions on those sidewalls—and a POSITA would have readily expected success in and predictable results from making these modifications, for a number of reasons.

181. First, as discussed above, Moran and Joo both come from the same field of endeavor: the design of transparent touch sensors for use in touchscreen devices. Ex. 1007 at 7:4-9; 6:7-26; Ex. 1008 at ¶ [0037]. Additionally, Moran's capacitive

touchscreens have the same elementary structure (a conductive touch-sensitive layer formed on top of a substrate layer, both of which are then layered on top of an underlying display, such as an LCD or OLED) as Joo. Ex. 1007 at 5:28-6:6; 6:30-7:3; Ex. 1008 at ¶¶ [0060]-[0062].

182. A POSITA further would have expected success in and predictable results from modifying Moran in the manner described above because of the inherent structural properties of the materials used to create Moran's touchscreen sensor, which were well-known in the art. Moran itself described that its PET substrate and silver/copper mesh micropattern electrodes were "substantially planar and flexible." Ex. 1007 at 8:13-21.

183. A POSITA would have been well-aware of these properties of silver/copper electrodes for a touch-screen sensor given the background art that I discuss above. For example, U.S. Patent Application Publication No. US 2010/0123670, filed by the same assignee as that of the '311 patent (Atmel Corporation) noted that metals such as copper or silver can be used to form "mesh" electrodes which are "malleable" and "can be readily flexed or kinked without damage." Ex. 1012 at ¶¶ [0008]-[0009]. A 2010 paper by Hu et al. explained that "outstanding flexibility makes the Ag NW [silver nanowire] electrode attractive for flexible electronics," such as "capacitive touch screens." Ex. 1018 at 2955; 2962. A U.S. patent application filed in March 2011 by Winoto et al. similarly noted the

"favorable physical and mechanical properties" of "robust and flexible" silver nanowire matrices for use in "touch screens." Ex. 1019 at ¶¶ [0025]; [0033]; [0081]. And as discussed above, Kuriki disclosed that silver wiring on a PET substrate could be wrapped around the edges and onto the back of an LCD panel. Ex. 1003 at 21:8-12; 27:48-28:38; 29:55–30:33).

7[f]: "one or more computer-readable non-transitory storage media embodying logic that is configured when executed to control the touch sensor."

184. Finally, a POSITA would have understood that Moran discloses this claim limitation. Specifically, Moran explains that its conductive micropatterns are electrically connected to "signal processing, logic, memory, or other circuitry for the purpose of using the micropatterns as part of a system (e.g., driving the conductive micropatterns with electrical signals for the purpose of capacitively detecting the presence or location of a touch event to an information display)." Ex. 1007 at 6:7-26. A POSITA would understand that at least the recited logic and memory are non-transitory storage media embodying logic that is configured when executed to control the touch sensor.

10.2. Claims 2 and 8

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor further comprises tracking disposed on the substantially flexible substrate configured to provide drive or sense connections to or from the drive or sense electrodes and configured to bend with the substantially flexible substrate."

185. A POSITA would have recognized that this claim limitation was disclosed by Moran as well. Specifically, Moran describes how its conductive "micropatterns" are "connected to . . . signal processing, logic, memory, or other circuitry." Ex. 1007 at 6:19-24. These connections are located in the "first and second conductive trace regions 706 and 726" that are also formed on Moran's transparent PET substrate. Ex. 1007 at 30:24-29; 31:9-12; 32:10-12. Moran's Figs. 11-13 illustrate these "conductive trace regions":

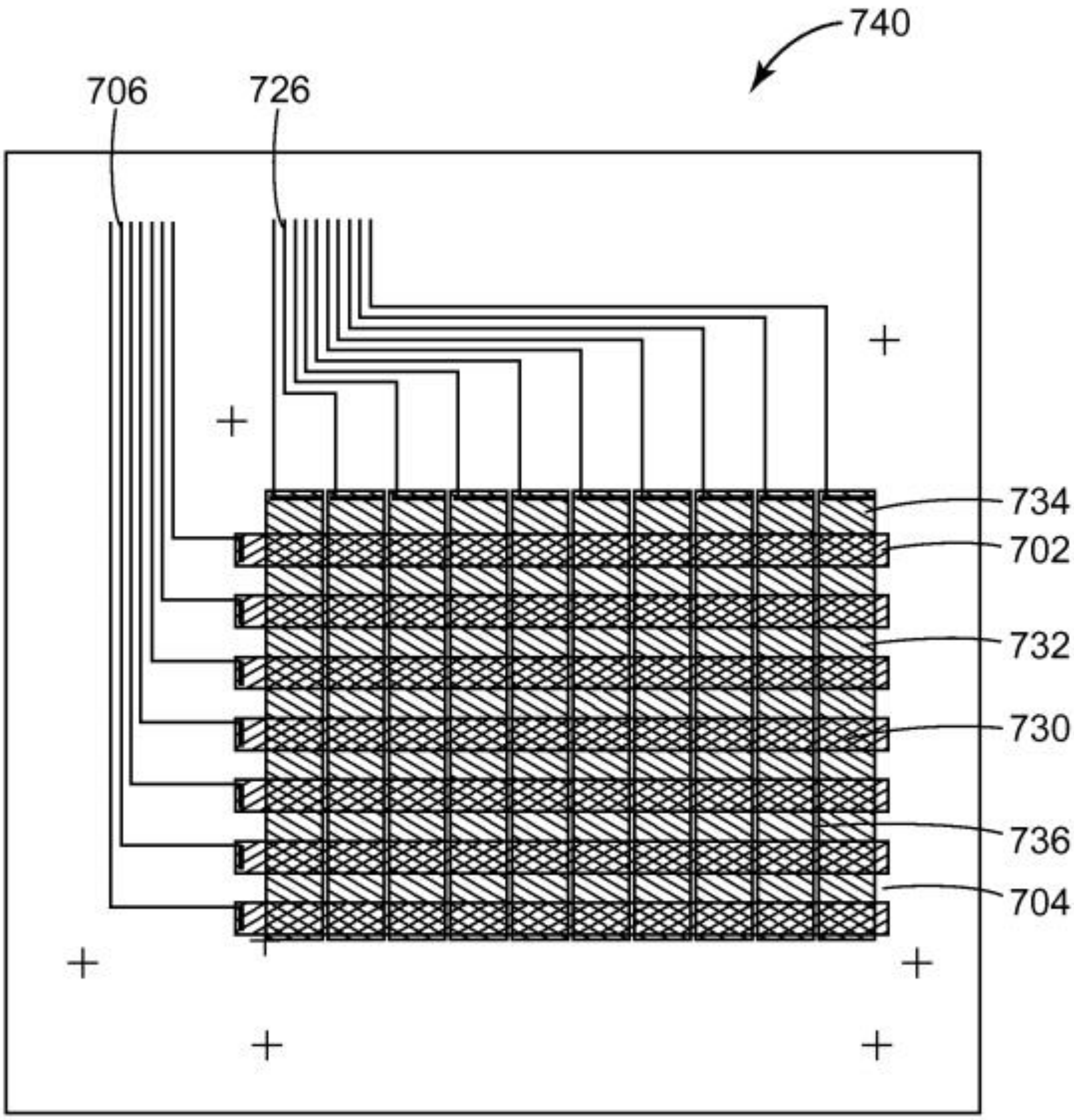


Fig. 13

186. Moran explains that these "conductive trace regions" connect to controlling circuitry that "drives[s]" some conductive micropatterns (the "drive electrodes") and "measure[s]" certain others of the conductive micropatterns (the "sense electrodes"), which the controlling circuitry utilizes to "make mutual capacitance measurements of the transparent sensor element." Ex. 1007 at 32:21-29.

187. Further, as discussed above, a POSITA would have recognized that Moran's copper and silver conductive trace regions would bend with the underlying flexible PET substrate. Moran itself discloses that its PET substrate and copper/silver micropatterns are "substantially planar and flexible." Ex. 1007 at 8:13-16. U.S. Patent Application Publication No. US 2010/0123670, filed by the same assignee as that of the '311 patent (Atmel Corporation) noted that metals such as copper or silver can be used to form "mesh" electrodes which are "malleable" and "can be readily flexed or kinked without damage." Ex. 1012 at ¶¶ [0008]-[0009]. A 2010 paper by Hu et al. explained that "outstanding flexibility makes the Ag NW [silver nanowire] electrode attractive for flexible electronics," such as "capacitive touch screens." Ex. 1018 at 2955; 2962. A U.S. patent application filed in March 2011 by Winoto et al. similarly noted the "favorable physical and mechanical properties" of "robust and flexible" silver nanowire matrices for use in "touch screens." Ex. 1019 at ¶¶ [0025]; [0033]; [0081]. And as discussed above, Kuriki disclosed that silver wiring on a PET substrate could be wrapped around the edges and onto the back of a LCD panel. Ex. 1003 at 21:8-12; 27:48-28:38; 29:55–30:33).

10.3. Claims 3 and 9

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are made from one of carbon nanotubes, copper, silver, a copper-based material, or a silver-based material."

188. A POSITA would have understood that this claim limitation was disclosed by Moran, as Moran taught that the conductive lines of its mesh electrodes are to be manufactured from silver or copper. Ex. 1007 at 22:13-15.

10.4. Claims 4 and 10

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor comprises: a single-layer configuration with drive and sense electrodes disposed only on a first surface of the substantially flexible substrate; or a two-layer configuration with drive electrodes disposed on the first surface of the substantially flexible substrate and sense electrodes disposed on a second surface of the substrate opposite the first surface."

189. A POSITA would have recognized that Moran discloses the claimed "single-layer configuration," in which both drive and sense electrodes are disposed on a single surface of the substantially flexible substrate. Moran states that "[t]he second conductive micropattern may be disposed on the same substrate as the first conductive micropattern." Ex. 1007 at 8:29-9:5. Further, Moran explains that these micropatterns are "patterned onto the surface of the substrate in a mesh geometry . . . provided that the second conductive micropattern . . . is electrically isolated from the first conductive micropattern." Ex. 1007 at 6:7-26.

10.5. Claims 5 and 11

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor is a mutual-capacitance touch sensor or a self-capacitance touch sensor."

190. A POSITA would have recognized that Moran discloses a mutual-capacitance touch sensor. Moran specifically states that its capacitive touch sensor is a mutual-capacitance sensor, explaining that it "make[s] mutual capacitance measurements." Ex. 1007 at 32:21-22.

10.6. Claims 6 and 12

"The [apparatus of claim 1/device of claim 7], wherein the touch sensor further comprises electrically-isolated structures made of conductive material comprising a conductive mesh."

191. Moran teaches that electrically "isolated squares of conductor" are located upon Moran's PET substrate in areas of the touch sensor in-between its conductive micropatterns to create "uniformity of light transmittance across the sensor." Ex. 1007 at 20:15-31. This is illustrated, for example, by Fig. 10 of Moran, which shows "mesh bars 441 that are electrically isolated from the electronic device" and which "serve to maintain optical uniformity across the sensor." Ex. 1007 at 28:3-25:

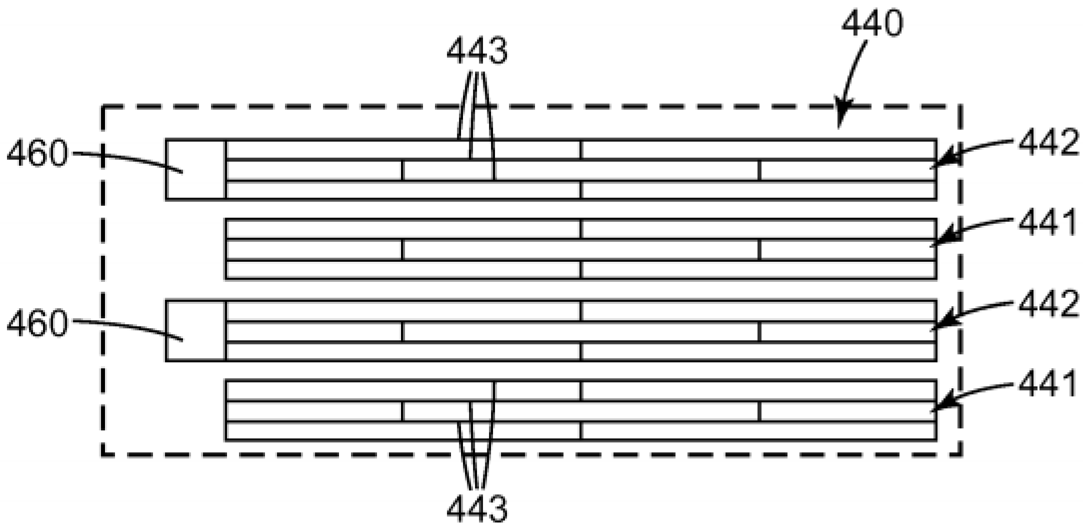


Fig. 10

10.7. Claims 13 and 16

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are substantially orthogonal to one another."

192. A POSITA would have understood this limitation to have been disclosed by Moran, which (for example) displays orthogonal first and second conductive lines in the exemplary pattern illustrated by Fig. 2:

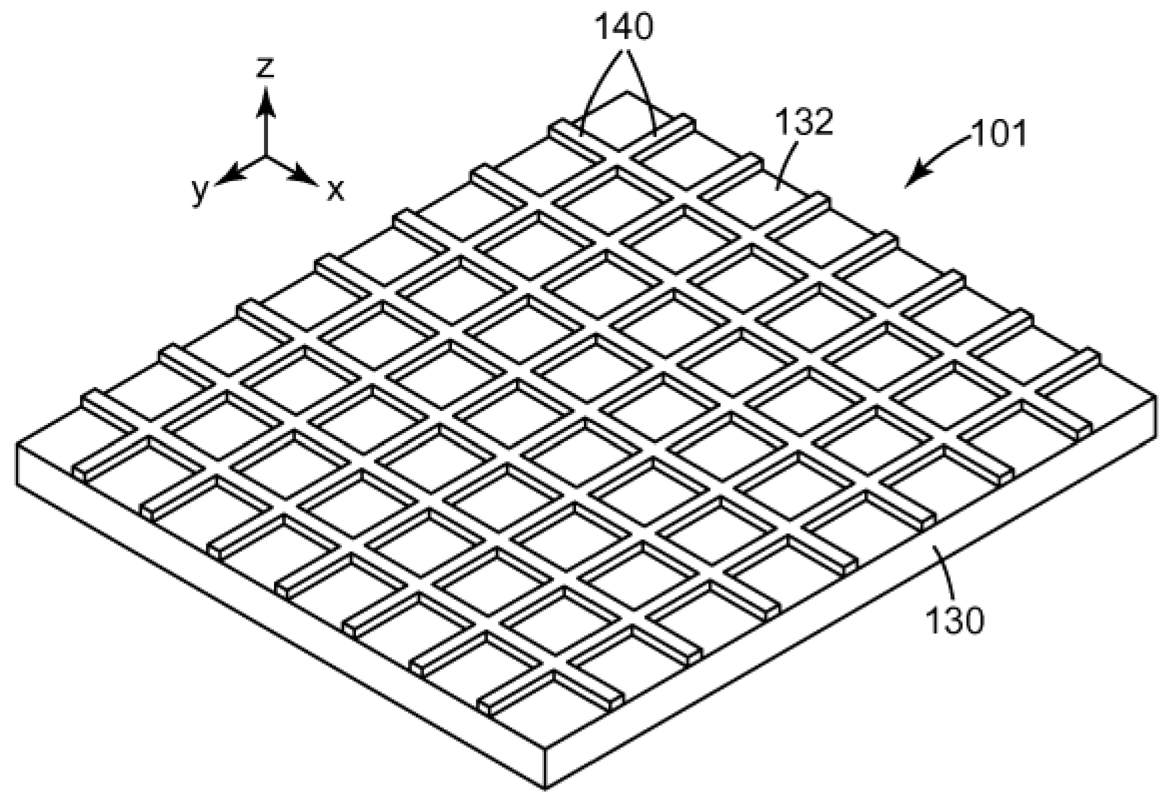


Fig. 2

10.8. Claims 15 and 18

> **"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are made of fine lines of metal having a thickness of approximately 5 micrometers or less and a width of approximately 10 micrometers or less."**

193. As discussed above, Moran's conductive lines that make up its "micropatterns" are composed of silver or copper. Ex. 1007 at 22:13-15. Additionally, Moran discloses that "the minimum dimension of the conductive pattern elements (e.g., the width of a line or conductive trace)" in those micropatterns "are between 0.5 and 5 micrometers, more preferably between 1 and 4 micrometers,

and most preferably between 1 and 3 micrometers." Ex. 1007 at 12:7-30. Moran also teaches these micropatterns are "relatively thin, ranging in thickness from about 5 nanometers to about 50 nanometers."[6] Ex. 1007 at 22:27-23:4. Accordingly, a POSITA would have recognized that Moran disclosed this claim limitation.

11. THE COMBINATION OF MORAN, JOO, AND PHILIPP

194. Philipp also comes from the same field of endeavor as Moran and Joo—the design of touch sensors for use in touchscreen devices. And Philipp addresses the same problem as Moran and Joo: the design of transparent sensors that can be layered over a device's display screen and used to create a touchscreen capable of controlling that device. A POSITA would therefore have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

195. The particular combinations of Moran, Joo, and Philipp's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis indicates that a POSITA would have had motivation to combine the features in Moran, Joo, and Philipp to arrive at what is claimed in the '311 patent based on the disclosures in the prior art and that POSITA's knowledge of the art.

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[6] 50nm is 0.05 micrometers.

11.1. Claims 14 and 17

"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines are non-linear."

196. Although Moran discloses that its mesh electrodes can have "wavy or irregular linear traces," Ex. 1007 at 9:32-10:3, Moran does not expressly disclose the use of *non-linear* conductive lines in its micropatterns. As discussed above, however, and as a POSITA would have recognized, Philipp discloses this claim limitation.

197. Specifically, Philipp describes mesh electrodes with internal conductive lines that are "wavy lines . . . formed of a series of curves," which "avoid creating moiré patterns when overlaying a display" and "long linear stretches of fine metal line." Ex. 1005 at ¶¶ [0030]; [0041]-[0045]. These non-linear, wavy lines are depicted in Fig. 4 of Philipp:

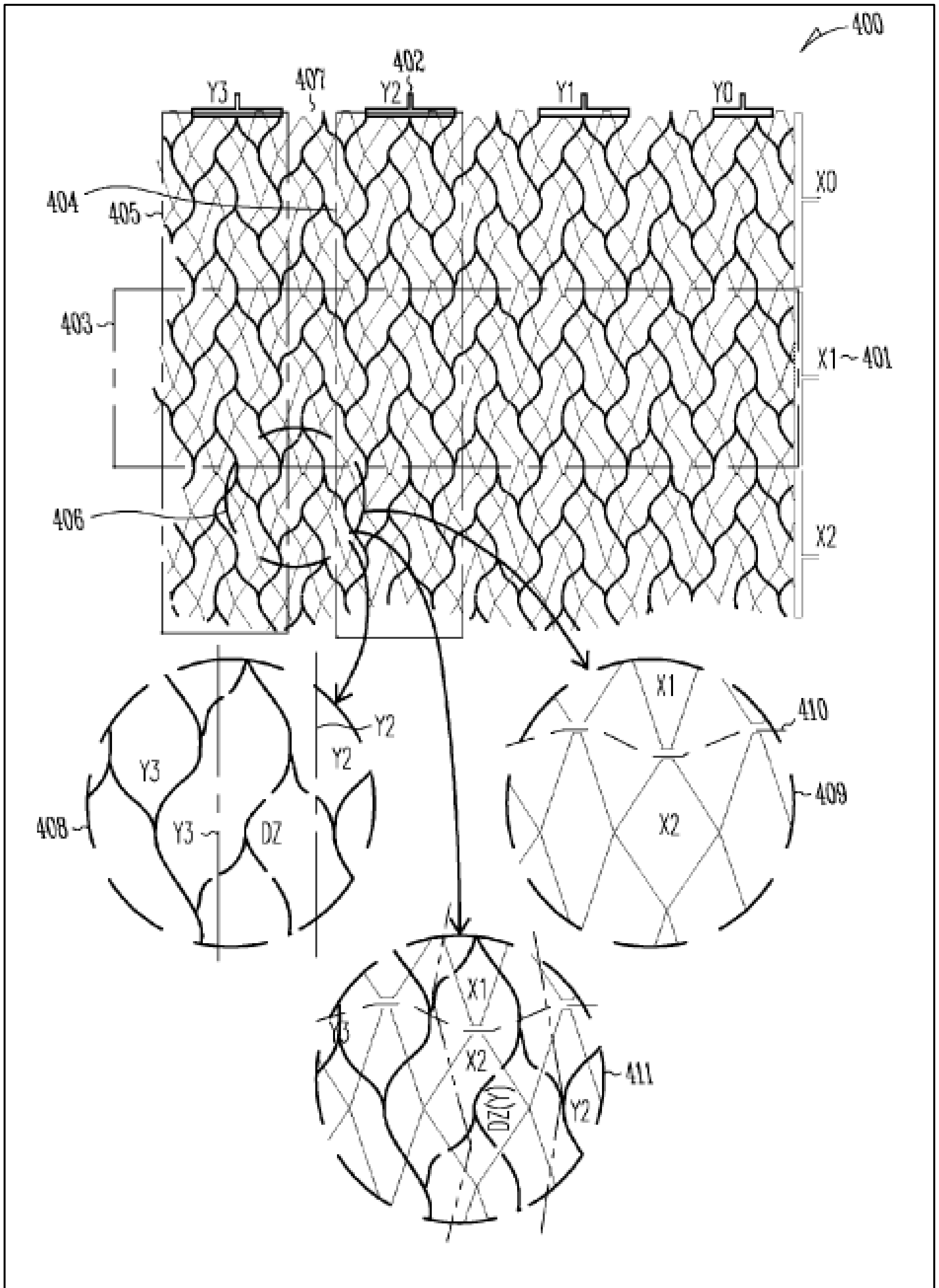

Fig. 4

198. A POSITA would have understood that Moran's "micropattern" electrodes could be modified to use "wavy," non-linear lines such as those utilized in Philipp's electrodes, instead of the straight, orthogonal lines depicted by Moran's

figures. And a POSITA would have been motivated to modify Moran in this manner to solve the problem that Philipp identifies as remedied by this modification: "to avoid creating moiré patterns between the display and the touchscreen." Ex. 1005 at Abstract. Philipp specifically notes that "wavy lines are used to avoid long linear stretches of fine metal line, reducing the probability of causing interference patterns." Ex. 1005 at ¶¶ [0030]-[0031]. Moran, too, has concerns about "minimizing interference such as moiré effects." Ex. 1007 at 12:15-18.

199. Additionally, it would have been straightforward for a POSITA to use Philipp's teachings to modify Moran in this way (incorporating wavy, non-linear conductive metallic lines into Moran's conductive micropatterns). As discussed above, Philipp, just like Moran, comes from the same field of endeavor—designing "mesh" electrodes to be incorporated into capacitive touchscreen sensors. Ex. 1005 at ¶¶ [0018]-[0019]; [0042]. And Moran similarly discloses the use of "wavy or irregular linear traces" in its conductive micropatterns. Ex. 1007 at 9:32–10:3. Accordingly, a POSITA would have readily expected success in and predictable results from making this straightforward modification.

12. THE COMBINATION OF MORAN, JOO, AND RAPPOPORT

200. Rappoport, like Moran and Joo, is directed to touchscreen devices with touch sensors, as discussed further below. Additionally, Rappoport, like Moran, is directed towards the manufacture of touchscreen devices that incorporate conductive

metal lines into their display. A POSITA would therefore have looked to the disclosures of these references together when designing a capacitive touch sensor for a touchscreen device.

201. The particular combinations of Moran, Joo, and Rappoport's features that a person skilled in the art would have had reason to make, and his or her reasons for doing so, are discussed in further detail below. In summary, my analysis indicates that a POSITA would have had motivation to combine the features in Moran, Joo, and Rappoport to arrive at what is claimed in the '311 patent based on the disclosures in the prior art and that POSITA's knowledge of the art.

12.1. Claims 19 and 20

> **"The [apparatus of claim 1/device of claim 7], wherein the first and second conductive lines of the flexible conductive material of the drive or sense electrodes is wider at the one or more edges of the display."**

202. As noted above, the combined teachings of Moran and Joo disclose wrapping the flexible conductive lines of mesh electrodes around the edge of a display. However, Moran and Joo do not expressly disclose that the width (or other dimensions) of these conductive lines are varied at the edge of the display.

203. As discussed above, a POSITA would have recognized that Rappoport discloses this claim limitation. Rappoport describes a touchscreen device where, at the edges, "conductive traces . . . such as control lines 62" "formed on the surface of [a] substrate 60" have been "enlarged (e.g. widened and/or thickened) in the vicinity

of bend axis 56" at the edge of the device where those conductive lines are bent. Ex. 1006 at ¶¶ [0038]-[0043]. Rappoport illustrates this technique in Figs. 7-9:

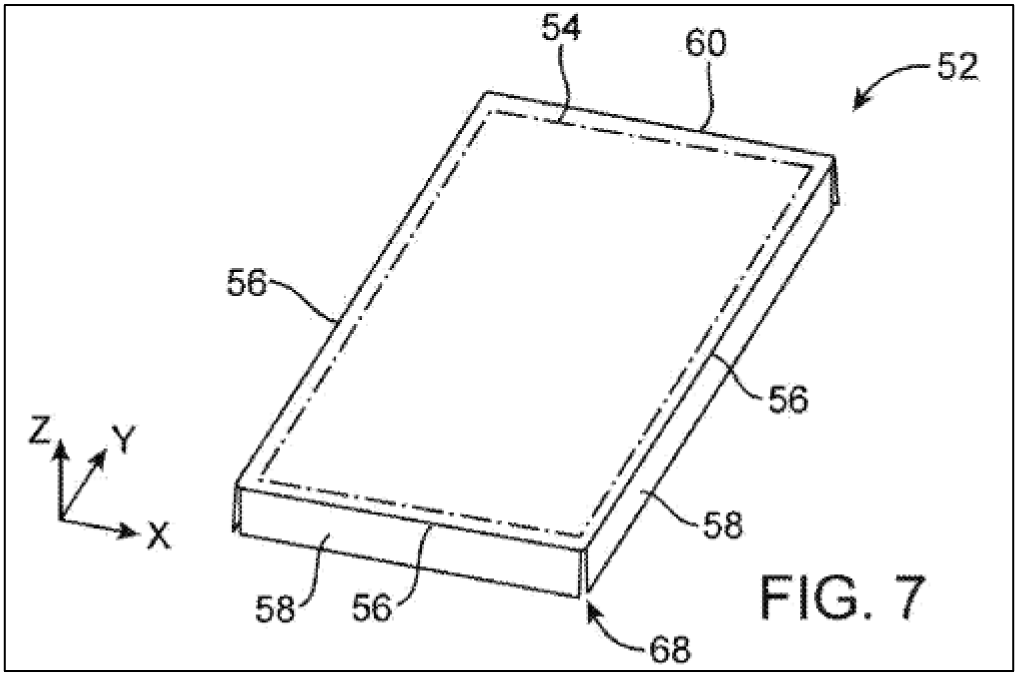

FIG. 7

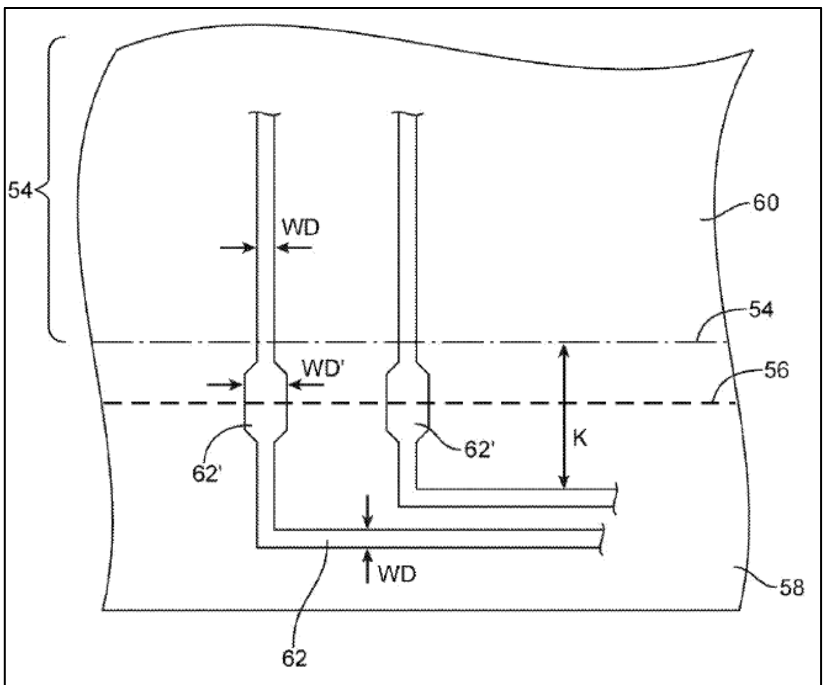

FIG. 8

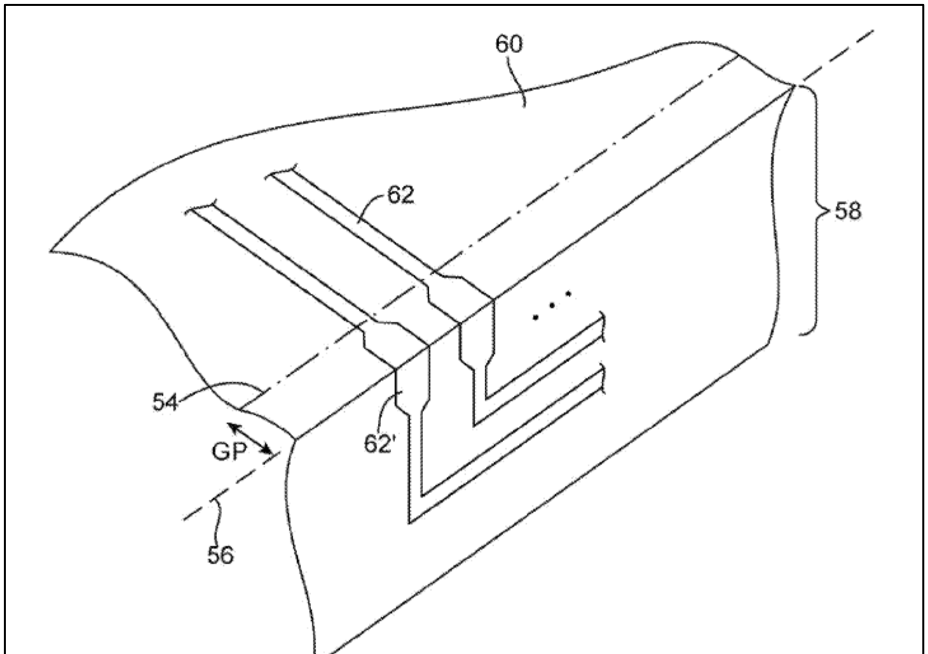

FIG. 9

204. In light of these teachings, a POSITA would have recognized that when Moran's capacitive touch sensor and its conductive "micropatterns" are wrapped around the edges of an underlying display and onto the sides of Moran's touchscreen device, as taught by Joo, the conductive metal lines in Moran's micropatterns located at the edges of that device's display could be widened, as taught by Rappoport.

205. A POSITA would have been motivated to use Rappoport's technique with Moran's flexible touch sensor for the reason provided by Rappoport: to "help ensure that traces 62 are not cracked or otherwise damaged" when wrapped around the edge of the device. Ex. 1006 at ¶ [0043].

206. Further, it would have been straightforward for a POSITA to use Rappoport's teachings to modify the combination of Moran and Joo in this way (to

widen the conductive lines of Moran's mesh electrodes at the edges of the device's display, where those lines would be bent). As discussed above, Rappoport, like Moran, is discussing the use of fine conductive lines at the edges of a touchscreen display. Ex. 1006 at ¶¶ [0029]; [0049]. Further, Kuriki, which also discloses the use of silver lines in a capacitive touch sensor, describes how the width of such silver lines can be successfully varied in the touch sensor, disclosing that "the first terminal wiring patterns 42a farthest from the center of the arrangement of the first conductive patterns 26A may have the largest line width, and the first terminal wiring pattern 42A closer to the arrangement center may have a smaller line width." Ex. 1003 at 21:55-65. Accordingly, a POSITA would have readily expected success in and predictable results from making this straightforward modification.

13. AVAILABILITY FOR CROSS-EXAMINATION

207. In signing this declaration, I recognize that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I also recognize that I may be subject to cross examination in the case and that cross examination will take place within the United States. If cross examination is required of me, I will appear for cross examination within the United States during a time as mutually agreed between the parties.

14. RIGHT TO SUPPLEMENT

208. I reserve the right to supplement my opinions in the future to respond to any arguments that the Patent Owner raises. This declaration represents only those opinions that I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information that becomes available to me and on my continuing analysis of the materials already provided.

15. JURAT

209. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

September 30, 2019
Date

Andrew Wolfe, Ph.D.